Cometographia

[Cometography]

(1668)

by Johannes Hevelius (Jan Heweliusz, 1611–1687)

Translation by Scott Weisman

Ars Astronomica

2026

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Translator Version 2

Upright reason dictates that the recipients of the good, of whatever type and level of beneficence it may be, must show gratitude and blessing to the beneficent person in every way possible, commensurate with the value of the beneficence. And one who has benefited all the people of the world — for example, one who invented a new instrument for the good of the world, or a good book — it is fitting for every discerning person, out of the obligation of love of fellow beings, to at least purchase it, so that the man will profit and his heart will be encouraged thereby to invent yet more good instruments in the world. And similarly, all other wise-hearted people will likewise strive and exert themselves to invent good things and instruments needed for the repair of the world and its perfection.

And therefore, whoever says: "What do I need this new instrument for?" — he does not act well towards the world. For if not for the man who invented it, where would you be? And what would your city do? And more than this, if the man did not exert himself, what would the world do?

— R. Pinchas Eliyahu Hurwitz, *Sefer HaBris HaShalem* (1797)

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A note on the work

Johannes Hevelius's *Cometographia* (Danzig, 1668) is the major pre-Newtonian survey of comets. Drawing on his own careful observations of the comets of 1652, 1661, 1664 and 1665 from his rooftop observatory in Danzig, Hevelius examines the place, parallax, distance, formation and dissolution of comets, the changing shapes of their heads and tails, and above all their motion, which he argued followed curved, near-parabolic paths rather than straight lines. The work closes with a history of every comet recorded from antiquity to his own day, annotated by the author, and a universal table of comets. Its many engraved plates, cut by Hevelius himself, are among the finest astronomical illustrations of the century.

A note on the translation process

This translation was produced with the translation-pipeline. See the linked repository for details on the process.

A note on the references. A scriptural or bibliographic reference given in brackets or parentheses is, in most cases, an **editorial identification of an allusion rather than a citation printed in the source**. Books of this kind quote and weave scripture constantly without naming it, and the identification is supplied here as a convenience to the reader. Where the source does print a reference of its own, it is given as printed. **An identified allusion is not evidence that the author cited that passage** — look at the original before resting an argument on one.

This text is the product of a highly refined automated translation process. It has undergone only cursory human review and should not be treated as an authoritative or scholarly rendering. It is offered solely as a reference and reading aid — a way to make an otherwise inaccessible work approachable — and any passage of real consequence should be checked against the original source.

Acknowledgements

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Notation and abbreviations

A few conventions have been applied uniformly throughout this translation, so that one quantity is always written one way. They change how a value is *written*, never what it is; where the printed source and this translation differ in notation, the source's own form is recorded in the editorial apparatus.

Numerals are Arabic, even where the source sets Roman ones. Roman numerals are kept only in headings, running headers and signatures, which are transcribed as printed.

Dates are given as year, month, day — *1572 November 11*. Dates are Julian, as the source gives them, and have not been converted to the Gregorian calendar.

Times are written with raised unit letters: $7^{h}\ 36^{m}\ 12^{s}$ for seven hours, thirty-six minutes and twelve seconds. An interval longer than a day carries a raised d — $3^{d}\ 7^{h}$. The degree and minute signs below are never used for time.

Angles are written with the conventional signs — 23° 27′ 30″. Early modern astronomy divides the degree sexagesimally and often runs to places for which modern writing has no common symbol; the orders used in this book are:

sign	order	the source's term
°	degrees	*partes*, *gradus*
′	minutes of arc	*scrupula prima*, *minuta*
″	seconds of arc	*scrupula secunda*
‴	thirds	*scrupula tertia*

A **sign** is 30° — one twelfth of the circle — and is written with a raised s: 5^{s} 3° 57′ is five signs and 3° 57′, that is 153° 57′. The source uses the sign both as a place in the zodiac and as a plain unit of 30° for a motion or a distance, and this translation keeps that distinction by writing the count rather than naming a constellation.

The signs of the zodiac. Longitude is reckoned eastward from the first point of Aries.

	Latin	English	longitude
♈	Aries	the Ram	0°–30°
♉	Taurus	the Bull	30°–60°
♊	Gemini	the Twins	60°–90°
♋	Cancer	the Crab	90°–120°
♌	Leo	the Lion	120°–150°
♍	Virgo	the Virgin	150°–180°
♎	Libra	the Scales	180°–210°
♏	Scorpius	the Scorpion	210°–240°
♐	Sagittarius	the Archer	240°–270°
♑	Capricornus	the Goat	270°–300°
♒	Aquarius	the Water-bearer	300°–330°
♓	Pisces	the Fishes	330°–360°

The Sun, Moon and planets.

	Latin	English
☉	Sol	the Sun
☽	Luna	the Moon
☿	Mercurius	Mercury
♀	Venus	Venus
♂	Mars	Mars
♃	Iuppiter	Jupiter
♄	Saturnus	Saturn

Abbreviations used in table headings: **Long.** longitude; **Lat.** latitude; **Decl.** declination; **RA** right ascension; **Alt.** altitude; **Az.** azimuth; **Asc.** ascension; **Diff.** difference.

Where a table in the source spreads one quantity across separate columns for degrees, minutes and seconds, those columns have been joined into a single column and the value written whole. Where a value runs to thirds and beyond, the columns are kept, since there the columns are the notation.

[Front cover of the binding: limp vellum with no title. A small oval armorial stamp stands at the centre.]

[Inside front cover: a Library of Congress bookplate, "THE LIBRARY OF CONGRESS / RARE BOOK COLLECTION", is pasted at the head. Below it, and partly hidden beneath it, is a later pencil note in German, a collation of the plates. It is only partly legible on the scan; what can be made out appears to read "title engraving; 34, of which 4 folding plates; 71 engravings in the text" [?].]

Diagram. Engraved frontispiece. In the night sky at upper left a comet trails its tail among scattered stars. At upper right an observatory terrace with a balustrade stands on a colonnaded building with a garlanded frieze; several figures on the terrace observe with a long telescope, a sextant and other framed instruments. Trees and hills fill the left middle ground, where a distant crowd points at the sky. In the foreground three robed men in caps gather at a draped table. The bearded man at left holds a scroll showing a circular diagram: a dark central disc, a ring of comets joined by a dotted path, and astronomical signs at the rim. The seated man at the centre points to a chart on the table drawn with concentric circles and a fan of radii about a radiant star, with planetary signs beside the inner arcs; a pair of dividers lies beside it. The man at right holds up a scroll showing a dotted semicircular track, a star, a fan of lines and a row of small comets. A globe on a stand stands at lower left, and a sextant-type instrument and a ring lie on the floor. The title is engraved in a scrolled cartouche at the foot of the plate.

- Left scroll, top and bottom: two crescent-moon signs (☾).
- Left scroll, upper right: one sign [?] — not resolved into a definite planetary sign.
- Left scroll, lower left: one sign [?] — not resolved into a definite planetary sign.
- Table chart, beside the inner arcs: about five planetary signs [?] — not individually resolved.
- Right scroll: no lettering seen.
- Cartouche: "JOHANNIS HEVELII / COMETOGRAPHIA." — Johannes Hevelius, *Cometography*.
- Below the plate frame, left: "Andr. Stech delin." — drawn by Andreas Stech.
- Below the plate frame, right: "L. Viſscher Sculps." — engraved by L. Visscher.

JOHANNES HEVELIUS'S COMETOGRAPHY,

setting forth the entire nature of COMETS:

namely their place, parallaxes, distances, origin and extinction, the various appearances and properties of their heads and tails,

and also their supremely remarkable motion —

all by means of a single hypothesis, and that one fixed and fitting.

In it, moreover, all the PHENOMENA and QUESTIONS concerning comets are deduced and demonstrated by evident reasons, and illustrated with a great many copper engravings.

Above all, the COMETS of the years 1652, 1661, 1664 and 1665, observed by the author himself with the greatest care, are set out and weighed at somewhat greater length and with greater care, and subjected to the most rigorous calculation.

To this has been added a HISTORY of all the comets recorded by historians, philosophers and astronomers from the creation of the world up to the present, enriched with the author's notes and comments, together with a special Universal Table of Comets.

With the privilege of His Sacred Imperial Majesty and of Their Royal Majesties of Poland and Sweden.

DANZIG.

At the author's own press and expense.

Printed by SIMON REINIGER.

IN THE YEAR 1668.

Diagram. Engraved headpiece above the dedication. A crowned king sits enthroned beneath a canopy, before a hanging strewn with fleurs-de-lis; his robe is also sown with fleurs-de-lis, and its train spreads across a tiled floor. Halberdiers in plumed helmets stand on either side of the throne. A kneeling man in a cloak lays an open book at the king's feet. At far left an armoured warrior in a plumed helmet, with a shield, stands among weapons, drums, standards and a pile of cannon-balls. At far right a helmeted female figure holds a spear and rests her hand on a shield bearing a Gorgon's head; beside her are an owl, a celestial globe on a stand, books, and a standard with a fleur-de-lis.

• No lettering was seen on the plate.

TO THE MOST POWERFUL, MOST INVINCIBLE, AND MOST CHRISTIAN KING OF FRANCE AND NAVARRE, LOUIS XIV, HIS BY FAR MOST GRACIOUS LORD.

Most Christian King,

the contemplation of a more hidden wisdom and of the science of the stars never more indeed flourished and grew than when it was the care and concern of princes and kings who held the sceptres of the world. This is perfectly well known to everyone from Ptolemy, King of Egypt; from Ulugh Beighi [Ulugh Beg], grandson of Tamerlane the Great; from the Emperor Rudolf; and from Kings Alfonso of Portugal and Frederick of Denmark, to pass over the rest.

We therefore now hope, with the assent of divine grace, for equally fortunate and immense progress in these sublime studies, since you, Most Christian King, deign to look down from the most exalted throne of Your Majesty, with so serene a countenance, both on the whole Republic of Letters and on the celestial disciplines as well. For Your Sacred Royal Majesty not only pursues all the sciences and liberal arts with ready love and honour, but also wishes, seeks and demands with the most ardent royal zeal that they be preserved, cultivated

and spread; so much so as to foster and stir up the more distinguished minds with its incomparable grace, and even to adorn them with the most splendid munificence, to draw them in and to bind them to itself. On this very great good fortune the whole learned world now congratulates itself most warmly, desiring nothing more ardently from the inmost depths of its heart than that this good fortune may last for ever, together with the felicity of Your Most August Majesty, which is to endure without end.

As for me, although I am the least among the measurers and cultivators of the stars and scarcely deserve the last place among them, I nonetheless, relying on your supreme clemency, revere no less, with the most submissive veneration, as is fitting, the illustrious grace and favour of Your Most Christian Majesty towards letters and men of letters, and I strive to proclaim and extol it for ever, publicly as much as privately; but above all because you, greatest King, me too, (although I have produced and published nothing but some slight specimens in the field of letters) — and a foreigner at that, lurking in obscurity — have not disdained, even though you see that your France is most fruitful in outstanding minds, most distinguished in every branch of learning, to draw me out into the fullest light and most graciously to receive me among men by far the most celebrated for fame and learning, whom you have judged worthy of your royal grace and protection, and indeed of your heroic liberality as well.

This has given me wonderful courage, so that I am now not afraid — something I should never have dared before — these Cometographic pages of mine, however very slight, yet gathered by me for the sake of illustrating and, if it can be done, even of enlarging the science of astronomy, with the most submissive and most obedient spirit, at feet of Your Most August Majesty. Although this little work is certainly far beneath so great a Monarch, yet since it is both of a noble and arduous subject and seems to look above all to the glory of the Supreme Deity and to the growth of divine Astronomy, Queen of the mathematical sciences, and since, besides, nothing else could come from my slender means on this occasion, I most humbly and most devotedly beg Your Sacred Royal Majesty to look upon it with a most serene countenance, and not to disdain to embrace its author himself further with Its most favourable grace and protection.

This royal indulgence — given Your Majesty's supreme benevolence and most ready goodwill towards our Uranian studies, such as they are, a goodwill long since well known to me — I too shall happily obtain, ful- ly confident as I am. Therefore I shall not only congratulate myself in private, but shall also be roused most greatly by the spurs, as it were, thereby applied, so that, aided by divine help, I may shortly complete, likewise under Your most happy auspices, my Celestial Machine and all my observations of the planets as well as of the fixed stars — drawn over many years, with the greatest labour and the utmost vigils, from the very aether with instruments not altogether unsuitable — together with a new catalogue of the fixed stars, enriched moreover with a great many new stars hitherto unknown and neglected, and bring them out

into the light; and so that I may once again attest before the learned world the most dutiful veneration of most humble gratitude that is owed to Your Sacred Royal Majesty.

To the immortal glory that Your Majesty has won by arms and trophies, as by letters most amply promoted, may there be added a felicity continued without measure: with a spi- rit sincere and most devoted I wish and pray for it.

Danzig, on the very day of the vernal equinox, in the year 1668.
Your Sacred and Most Christian Majesty's
most humble and most submissive
J. Hevelius.

Diagram. A circular engraved vignette, the only printed matter on the page. Above, a winged figure in flowing drapery flies among clouds, blowing two long trumpets, from each of which hangs a banner bearing three fleurs-de-lis under a crown. Below, a closed royal crown topped by a fleur-de-lis is borne on a pair of spread wings amid clouds and rays; coins or medals and laurel wreaths fall from it onto a heap of books (one lying open to show a crescent and a full disc), a celestial globe on its stand, a telescope, a quadrant-like instrument, a cross-staff, a compass rose and other instruments.

- Lettering: none seen on the vignette, its banners, books or instruments. The faces of the coins or medals were not resolved.

Diagram. An engraved headpiece across the upper third of the page. At top centre, a glory of rays breaking through clouds holds the divine name in Hebrew letters. Choirs of winged angels sit on banks of cloud to either side: those on the left sing from open books, those on the right play a lute, a large bowed string instrument and other instruments. Small winged heads appear among the clouds.

- Glory (top centre): יהוה [Hebrew: YHWH, the divine name], four letters, with a vowel point under the third letter whose form was not resolved.
- No other lettering on the engraving.

To the Kind Reader, Greeting [Benevolo LECTORI S.]

The mind and will of man must certainly be occupied at all times in declaring the glory of God, in searching out the truth, and in increasing the common good. For just as all things in the whole universe were founded for the sake of the human race, so the human race in its turn was created solely for the sake of God: so that it may praise and celebrate for ever the Parent and Founder of all things and of itself, and acknowledge with its whole heart, magnify, and extol with all its strength His admirable power, ineffable magnificence, and goodness, with which He fills the entire world. In this the most holy Patriarchs and all the Prophets carry the torch before us most beautifully; and so too we have a truly great admonisher and spur in King David, interpreter of the Divine Mind, who rouses himself and all of us with these words: BLESS JEHOVAH, O MY SOUL; PRAISE, CELEBRATE HIS NAME, ALL NATIONS, ALL

PEOPLES; SING, MAKE MUSIC TO HIM, SPEAK OF ALL HIS WONDERS; LET EVERY SPIRIT PRAISE THE LORD.

For indeed, whenever we look at even the smallest works of Nature met with anywhere on the globe — whether the minerals in its bowels, the plants and animals on its surface, or finally the meteors in its atmosphere, of whatever kind they may be — and weigh them a little more deeply, the omnipotence, infinite wisdom, and incomprehensible providence of the Divine Majesty shine out clearer than daylight. More than that, all these things give us occasion, and kindle in us the ardour, to proclaim with a most grateful mind the glory, honour, and power of the supreme Maker of things. But above all, if there is anything that more strongly fires the minds of good men and drives them to pour out and render due praises and suppliant thanks to God Most High, it is the sight and contemplation of the vast Celestial Machine. For THE HEAVENS DECLARE THE GLORY OF GOD, AND THE FIRMAMENT PROCLAIMS THE WORK OF HIS HANDS. In the firmament the magnificent Founder of things displays the spectacles of His immense wisdom and His unspeakable works — indeed, miracles for the human senses to wonder at without stint, and equally to search into. So many stupendous and vast bodies present themselves there: not only the Sun, the fountain of light, the Moon, the planets, and the other innumerable fixed stars, as ordinary and eternal bodies, but also extraordinary ones, sometimes temporary too, that come forth into our view, such as new stars and comets. The more rarely these are brought forth from the abyss of Nature and set out before us on high, the more the Supreme Godhead inflames and stirs all mortals: not only to gaze at them and marvel at them on the surface and from afar, along with the common people, but — as befits men especially who are wise somewhat above the common measure, and more capable than others of these sublime things — to look into those hidden secrets and mysteries rather more deeply, and indeed as if at close quarters, with sufficient and suitable instruments applied for the purpose, and to investigate them further. And this with the end, namely, that not only they themselves the unspeak- able works of Jehovah and His mighty deeds more and more, and extol them, but may also rouse others, and indeed even late posterity, and lead them by example to pursue similar things and gradually to search them out more intimately. In this way the most abstruse treasury of celestial things may become more thoroughly known to the whole world; the good arts and sciences, the sidereal ones above all (which God, Best and Greatest, wills no less to be increased and adorned step by step), may take greater growth day by day; and the whole Earth — recognising the eternal Providence, even from the wonderful face, tail, and size of the adventitious bodies too, and above all from their motion, by far the most admirable and the most varied, through that hidden symmetry and unsearchable harmony, however much it is known only in part — may rise up for ever to the admiration, love, and praise of the Supreme Godhead.

Since this is so, and since it falls to everyone to do and pursue this vigorously, according to the measure granted by God, we certainly thought it our part as

well — above all since I have felt in my mind, from my very youth (which I attribute to the Divine Benevolence), an ardour to attempt this and to undertake Uranian contemplations — to weigh and search out, as far as the strength of my ability allows, among the other ethereal bodies, the nature, affections, and properties of the hairy stars in particular. But I willingly grant, even without anyone's reminding me, that this matter of comets is, if any among other things and questions is, extremely difficult, most obscure, and most intricate. Very many philosophers, ancient as well as more recent, have debated it keenly, indeed beyond what can be said; yet even after so many centuries it has not been thoroughly discussed up to now, still less decided, so much so that it remains in doubt even among the greatest of philosophers. Nevertheless I persevered steadily in my purpose (however well I knew the weak powers of my ability, and acknowledged that I am in no way to be compared with those most famous and most learned men who long ago attempted this matter of hairy stars), and I by no means allowed myself to be torn away from it by these difficulties, being firmly persua- ded that in the investigation of Nature one must not lose heart at once; next, that we have by no means been placed by God in this theatre of the world in vain; and further, that the person who has hoped the truth can be found contributes most to discovering it and to advancing the truth of the sciences — as Seneca holds (*Natural Questions* [Natural. Quæſt.], Book 6, Chapter 5). Added to this is the fact that, as we have just touched on, it falls to us to devote ourselves with our whole mind, as far as we can, to inquiring into the truth and passing it on faithfully to posterity. Therefore, although the matter is exposed to very many difficulties, is especially arduous, and appears to require much labour, none of this should deter us in the least. Rather, we must undertake the matter with all the greater desire, zeal, labour, and constancy, trusting entirely in God that He will most kindly grant His grace for carrying out such a praiseworthy endeavour — one that serves the glory of His Divine Name, and truth and the common good — and for bringing it out into the light. In this way, even if not everything can be completed fully in every part, at least some things may be added to what has so far been found and detected, and be worked out somewhat more diligently. For Nature, according to that saying of the Roman philosopher, does not hand over her sacred things all at once: she willed nothing great to come about quickly, but set a difficulty before every finest work, to be overcome at last by labour and practice. Moreover, our minds could be kindled in no small measure to take up and carry through this business the more eagerly by what the most wise man just praised pronounced, as if foretelling it, in Book VII, Chapter 25 of the *Natural Questions*: The time will come when our posterity will wonder that we did not know things so plain. There will be someone who will one day show in which regions comets wander, why they travel so far apart from the others, and how large and of what kind they are.

But I would not have you think, friendly Reader, that I credit the powers of my ability with so much, and claim so much for myself, as to believe that I

am the one who has been granted all the faculties and gifts needed to put the final hand, now at last, to that matter, by far the greatest and the most involved. So far indeed is it from the case that this sweetness of vain confidence has ever soothed my mind, that ra- ther I never let myself be persuaded that the day would come when I would take up even some rather slight remarks on this so deeply hidden matter of comets, let alone set them down in writing and send them out to the public.

Several years ago, however, with God's favour, our Selenographic work was brought to its end with favourable success, and at the same time the fairness and goodwill of readers became plain: I understood that those efforts of ours had not displeased them all that much. I therefore judged that this too fell to me — to discharge the promise made in the Preface and the Epilogue of the *Selenographia*, and to put in strenuous effort, as far as my strength allowed, so as to make public, with the best of intentions, what I had so far hunted out privately with the greatest zeal. Accordingly I believed I must go on along that road once attempted, since it is finer even to spend one's life for the public than to pass one's time — than which nothing is more precious — in ignoble torpor.

Strong spurs were added a little later, when at almost that very time, by what was, as it were, a singular fate — namely in the year 1652 — a certain hairy star [Sidus quoddam crinitum] had shone out. At my first sight of it, I confess, I was roused to a remarkable degree to continue tirelessly those celestial observations begun long before. The appearances of comets have indeed for the most part been, as it were, incitements and rousers for observers of the heavens [Uranoſcopis], urging them to cultivate and advance astronomy more successfully. That this is so is not hard to prove from the examples of many most distinguished men, such as Hipparchus, Regiomontanus, Tycho and others. For the first and the last of those I have named, seizing that occasion, were moved to dare a thing presumptuous even for God, if we may speak so — to count out the stars for posterity and to set out the courses of the stars by rule; the middle one, for his part, undertook to establish the method of observing parallaxes. I say nothing of how many notable things, hitherto unknown, have been discovered and explored by many others thanks to the more recent comets. For my part, to confess frankly about myself how the matter stands: even if I do not come into the reckoning of those eminent men, unless the comet had shone out in the year I have mentioned, 1652, I would never by any means have been drawn into that immense and austere labour: measuring the wandering and the fixed stars — not only all the old ones, but many new ones besides — compiling a new catalogue of the fixed stars [Inerrantium Catalogum], and composing this very *Cometography*.

At first I had decided on nothing more than to draw accurate observations of that comet from the sky itself, as far as could be done at that time, so as to investigate more thoroughly its apparent and its true motion, and also its place, size and distance from the Earth. But once I had set my hand to the work and begun the calculation, I saw at once that the labour would not be altogether

fruitless if, at the same time, those various questions met with everywhere among astronomers and philosophers — and, besides, others descending one from another — were thoroughly shaken out, and if the observations of other comets too were subjected to the most exact calculation possible and examined to the bottom. For in that way, I thought, something solid could at last be pronounced and established about the fixed course of comets, their origin and their end [Ortu, & Interitu], and about so many very diverse phenomena and theories. And yet these very things would have deterred me almost on the threshold, had I not taken heart again and again and believed that, with God's help, the matter must be carried through, and that one must go as far as one could reach. In great things, surely, even to have willed is enough.

Having therefore humbly implored divine aid, I undertook, on the occasion both of the comet of the year 1652 and of certain later ones, to compose a universal *Cometography*. With all the zeal I could, I began to describe and explain the whole nature of comets: their place [Sedem], parallaxes, distances, origin and end, likewise the wonderful appearances and properties of their heads and tails, and above all their motion, both apparent and true, which is supremely to be admired. And I did so in such a way that, by proposing a single hypothesis, and that a firm and fitting one, I strove to demon- strate everything and illustrate it with examples; to examine, too, all the phenomena that arise and the questions partly already raised and partly still to be raised; to establish our own view with solid reasons; and briefly to refute the opinions of our opponents. Briefly, I say, because, so that this work should not swell to an excessive bulk, I was always more concerned to go about strengthening our own view than to set about demolishing other people's entirely.

In general, however, we have laboured to this end: that in this philosophical matter we should also philosophize freely and not heed the authority of anyone, whoever he might be — in those matters, that is, where sense, reason and observation evidently proved the contrary. In this we follow the precept of our most illustrious Royal Society and its motto: NULLIUS IN VERBA [on the word of no one]. If everyone, and indeed our posterity too, would set their feet in such tracks, judging that philosophy is not to be cultivated as if handed down by descent [ex traduce], nor that one may rest securely in certain pronouncements and discoveries of the ancients, there is no doubt that the boundaries [pomœria] of the sciences and arts will be advanced to a wonderful degree, that the recesses of things will at last be opened out, and that new marvels, still hidden in the vastness of Nature, will day by day be most happily disclosed — as a most beautiful hope already shines out — and, drawn into the light, will be set before the eyes and the gaze of all.

As for the order of this work, we have followed the one that the nature of the material itself, and of the observations, dictated to us. In the First Book, therefore, we have dealt specifically with the comet of the year 1652 [Anni milleſ. ſexenteſ. quinquageſimi ſecundi]. We subjected its observations to the most rigorous calculation, so that the apparent motion of that comet —

both with respect to its orbit and with respect to the ecliptic and the equator — and the other matters belonging to it might be worked out, and a solid foundation thus laid from which the parallaxes and the remaining matters could be more correctly derived and deduced. In the Second we have shown clearly that both the comet just named and all the others were ethereal. In the Third, on parallaxes in ge- neral, of all comets we have treated, though in a plainer fashion [rudiori tamen Minervâ], and from them we have likewise established that comets move in the highest aether.

In the Fourth, we deal with the parallaxes of the comet of the year 1652, both vertical and horizontal, investigated by a more accurate method. There it is shown not only by what route — and that a very diverse one — they are precisely worked out, and on what supports, as it were, they rest, but also how laborious and subtle a business it is if anyone tries to follow out each step accurately. To this were added very many axioms, supremely necessary for carrying out that method correctly, with the procedure shown at the same time and followed throughout for the comet of 1652. And since the matter is most intricate and very difficult, I thought it necessary also to present almost the entire calculation, and to attach to each example its own diagram [Schema] for greater clarity — especially since, so far as I know, parallaxes have not until now been investigated by this new method, let alone sufficiently demonstrated by geometrical calculation.

In the Fifth, it is proved from the distances of comets from the Earth that they are not sublunary but celestial. In the Sixth, we deal with the apparent and the true size of the head and of the tail, and likewise with the light and colour both of the comet of 1652 and of others whose observations reached our hands; at the same time all the phenomena and questions bearing on this subject are investigated and discussed. In the Seventh, we have discussed the origin of comets, their genuine matter, form, properties and end, and have set out our view on all of these at length. In the Eighth, we have treated the tails of comets and their various phenomena, colour, light and wonderful appearances, and we have presented them drawn from life and engraved in copper by our own hand, like all the other figures. In the Ninth, the motion of comets is explained at length: where, namely, does it arise? Does it proceed in a circle, or in a straight line, or in a conic one? Is it equal or unequal at all times? Further, what increases and decreases of speed and slowness does it undergo? — and a great many other matters of this kind. By the same labour, however, our hypothesis too is explained at length, and it is clearly shown that by its means all comets can be conveniently accounted for [sustineri], and every inconsistency met most correctly — as we have gone on to elucidate and establish there by a more accurate calculation, by examples, and by a great many figures.

For the rest: while I was labouring on these things, other highly notable comets besides came my way, and I thought it not beside the point to search out their observations with equal diligence — above all because this was very much in keeping with our plan, and it seemed that much light would accrue

to this work from it. Accordingly, although I had firmly resolved to crown the whole work with the Ninth Book, judging that in the preceding books almost all the material had been examined amply enough, unless my opinion deceives me, I nevertheless promptly changed my mind and added three further books.

The Tenth, indeed, for this reason: that I might also investigate the comet of the year 1661 more exactly and weigh each of its particulars, since, using very large instruments, I had successfully collected sound observations, highly useful both for explaining any phenomena whatever and for confirming our hypothesis. In the Eleventh Book, then, are set out the matters concerning the two later comets that remained after the publication of our *Prodromus* and *Mantissa*: namely, the genuine hypotheses and the parallaxes of these comets. Above all, we have shown at very great length, from a great many observations, and those by no means trivial, presented in the *Mantissa*, that our theory can be established no less for these last three hairy stars [Sideribus crinitis], consistently in every respect, and that no phenomenon whatever is met with in them that does not likewise obey our laws and avoid all absurdities. Finally, in the Twelfth Book I have comprised the history of all comets, from the creation of the world down to these our times, whichever were recorded by historians, chronologers and astronomers. Since I judged that it would be no useless labour if, of each and every co- mets, their remarks [Animadversiones] — astronomical ones, that is — were gathered as it were into a single bundle, with all the rest, which are not at all to the point, entirely discarded. For it is perfectly clear what examples and various observations contribute to the understanding of things, especially if they have been carried out and recorded accurately. But how meagre are the observations we have of past comets — apart from a very few more recent ones gathered in this and the previous century — the history of comets itself clearly proves. If our predecessors had handed down to us more, and more certain, information on this subject, there is no doubt that this history too would have been made far richer. But what has so far been neglected in this area through the carelessness of others must be repaired in the course of time by our own care and zeal and by that of posterity; and we wish with all our heart that this may come about and succeed happily.

You have, then, a succinct outline and, as it were, an idea of this whole cometographical work. If you want more, and more particular, detail, my reader, you may, if it is not burdensome to you, either read the whole volume through or at least run through it with a passing eye. I have no doubt at all that you will recognize that, although on this most profound subject I could not satisfy everyone — much less bring the matter to the point where nothing whatever is left over for others — I have nevertheless at least laboured toward that end as far as the feeble powers of my mind allowed; that I have left nothing untried, and have spared no labour, however extremely tedious, so as to track down the truth by every means. And if I have not yet entirely found and uncovered it, as could hardly be done so easily in so arduous a matter, I shall hand the torch, with entire equanimity, to you and to our successors, for

something more excellent and more solid to be worked out and produced. For one age is not enough for the investigation of such great mysteries. We indeed hold the most certain hope that at length, some day, either you or others — men, that is, of weightier learning and loftier genius — more closely than has hitherto been done by our- selves, will take aim at the mark — above all since in this our age supreme kings and princes, a thing in which the whole learned world greatly rejoices and glories, not only love distinguished men devoted above all to the advancement of natural science and bestow every honour on them, but also, by their singular grace and clemency, most kindly spur them on and wonderfully kindle their spirits.

For my part, I am fully content with the testimony of my conscience that in this little work I too have attempted something here, and have sought to discover in this arduous business of comets certain things which, as I judged, bear on the glory and honour of the Creator of the ages [Conditoris ævi], and on bringing the truth to light and advancing the public good.

Of your fairness and kindness, kind reader, I promise myself with certainty that you will value at their proper worth, as is fitting, these efforts of ours, such as they are: undertaken in a good spirit, and carried through with the greatest labour, with no small wasting of my bodily strength, on account both of the very extensive calculation and of the very many figures engraved in copper by my own hand. But if you find that I have now and then strayed, as humans do, and miss certain things in some places, I trust that you will readily forgive it to the slenderness of my talent and to the manifold and very heavy occupations, public as well as private, by which I am overwhelmed almost day and night.

As for the rest [Quod ſuperſt] [recte: Quod ſupereſt], I gladly and reverently submit everything contained in this work to the judgement of all who both love and understand the truth, and above all to the most wise censure of our most illustrious Royal Society. If I see that there is someone able to bring forward a more fitting hypothesis, supported by more solid and more evident reasons and demonstrations, and to overturn ours completely, I shall hand him the grass [herbam porrigam — that is, concede victory] not unwillingly; indeed, I shall gladly congratulate myself and my victor alike. For I never cling so stubbornly either to my own opinion or to that of any master, of whatever authority he may be, that to a truer view — as anyone devoted to wisdom, and to whom petty vainglory is ab- horrent, ought — I would not most gladly yield. Let truth therefore prevail, let virtue prevail (to make my own the words that the most learned Jeorgii Joachimi Rhetici [Georg Joachim Rheticus] uses in his *Narratio prima* to Schonerum [Johannes Schöner]), and let the arts always be held in their due honour, so that every good practitioner of his art may bring to light whatever is of use, and defend it in such a way that he may be seen to have sought the truth. Farewell.

[Privilege]

Imperial Privilege [Privilegium Cæſareum.]

We, Leopold, by the favour of divine clemency elected Roman Emperor, ever August, and King of Germany, Hungary, Bohemia, Dalmatia, Croatia, Slavonia, etc., Archduke of Austria, Duke of Burgundy, Styria, Carinthia, Carniola and Württemberg, Count of Tyrol, etc., acknowledge and make known to all by the tenor of these presents:

Our honourable, faithful and sincerely beloved Johannes Hevelius, consul in the Old Town of Danzig, has had it most humbly represented to Us that he has not only already published various mathematical works in print, but also has in hand certain further studies [lucubrationes] belonging to the same discipline. By these he hopes that this age of ours, and above all the discipline of astronomy, will be notably enriched, and that all the learned men of the Christian world will be greatly helped; and he wishes to entrust them to a printer of his own to be printed, and to make them public. To this end he has acquired, at his own expense, no ordinary printing equipment. He fears, however, that (as usually happens) other printers too, for the sake of gain, may fraudulently imitate the same books to his great loss, commit them to the press, distribute and sell them, or else disturb him in some way in publishing those works of his with his own type. He has therefore humbly begged Us to deign graciously to protect him with Our Imperial Privilege, by which he would be safeguarded, in the Holy Roman Empire as well and in Our hereditary dominions, against all frauds and disturbances of this kind.

Since We always judge those who apply their distinguished talents to the further advancement of liberal studies and disciplines to be worthy of Our Imperial favour, and have resolved to accede to this petition, as humble as it is fair, We therefore firmly forbid and prohibit each and every printer, bookseller and anyone else whatever who carries on the book trade from presuming to disturb the said Johannes Hevelius in his undertaking. Nor may anyone, for a period of twenty-five years — reckoned, both for the books already published and for those still to be published, from the first day of publication — within the bounds of the Holy Roman Empire and of Our kingdoms and dominions, reprint the books he has published heretofore or will publish hereafter, in similar or any other type or format, wholly or in part; give them to others to be reprinted; or bring in copies printed elsewhere, sell or distribute them, secretly or openly, against the will and without the consent and licence of the said Johannes Hevelius and of his heirs and successors.

If anyone, acting otherwise, dares to violate or transgress this Imperial privilege and prohibition of Ours, We decree that he shall not only be deprived in fact of such books, wrongly reprinted and imported (which the said Hevelius, or his heirs and successors, may claim for themselves wherever they are found, either on their own authority or with the help of the magistrate), but shall also be fined, with all hope of pardon removed, ten marks of pure gold, to be paid in equal shares to Our Imperial treasury and to the party who avenges the fraud and disturbance. Provided, however, that four copies of each book are sent to

Our Imperial Aulic Chancery, and that the tenor or an extract of this present Privilege of Ours is printed at the front of the books to be published hereafter. We therefore command all Our and subjects of the Holy Empire and of Our hereditary kingdoms and dominions, of whatever estate, rank, order, dignity or pre-eminence they may be, ecclesiastical as well as secular, and especially those who, placed in office, administer law and justice either in their own name or in the name and place of their superiors: that they allow no one rashly and with impunity to transgress or violate this Imperial privilege of Ours, but rather see to it that any offenders they discover are punished with the prescribed penalty and pursued by other means, inasmuch as they themselves would not wish to pay the same fine. Witnessed by these letters, signed by Our own hand and secured with Our Imperial seal. Given in Our City of Vienna, 1662 March 6, in the fourth year of Our Roman reign, the seventh of Our Hungarian, and the sixth of Our Bohemian.

Leopold
L. S. [the place of the seal]
Wilderich, Baron von Walderdorff [Wildericus Baro de Walderdorff.]
By the express command of His Sacred Imperial Majesty.
J. Walderode

Royal Privilege [Privilegium Regium.]

We, John Casimir, by the grace of God King of Poland, Grand Duke of Lithuania, Ruthenia [Ruſſiæ], Prussia, Masovia, Samogitia, Livonia, Smolensk and Chernihiv [CZernichoviæq;], and also hereditary King of the Swedes, Goths and Vandals, make known by these Our present letters to each and every person whom it concerns, or may in any way concern:

We have always judged worthy of Our Royal grace and favour those who apply their distinguished talents to the further advancement of the liberal disciplines, and who thereby gain renown both for themselves and for the arts they practise, and moreover bring forth outstanding fruits for the use of common life and benefits for distant posterity; and We consider that to encourage and spur on such men belongs above all to the office of Our Royal Dignity. We have learned, from persons whose good faith is proven to Us and who are able to judge the sublime sciences, that the noble and worshipful Johannes Hevelius, consul of Our Old Town of Danzig, faithfully beloved by Us, has for a good many years now cultivated the mathematical disciplines, above all astronomy, with excellent talent, exact judgement, untiring labour and, finally, the greatest expense. He has done so to such effect that he has not only collected countless new and rare observations and, by publishing a number of most accurate writings based on them, has so far enlarged the broad estates [latifundia] of that celestial science, to the highest applause of all the learned in the Christian world; but he also now has in hand works by which this age may be notably adorned, and divine Astronomy brought, as it were, to its perfection, with a splendid yield that will flow from it to other excellent

matters and to the common use of life. This he does above all by means of his machines and astronomical instruments and the exquisite mathematical apparatus belonging to them, the equal of which Europe does not have at this time, and which We Ourselves, being at Danzig about two years ago with the Most Serene Queen, Our most beloved consort, surveyed graciously with Our own eyes and in admiration.

Moved by all these things, and from Our kindly inclination towards him, We have undertaken to honour the said noble Hevelius with Our Royal commendation for so many excellent endeavours and labours — also for the sake of the commonwealth itself, to which he contributes these things as an ornament — and, although he is sufficiently encouraged in himself, to encourage him further and to defend him with Our patronage. And since We have learned that he wishes to entrust the studies he has in hand to a printer of his own to be printed, and has acquired for this purpose, at his own expense, no ordinary printing equipment, We wish the aforementioned Hevelius and his printer to be protected against the frauds of any persons who might perhaps wish, for the sake of gain, perversely to print the same studies and to imitate them in type.

For this reason, by Our Royal Authority, We prohibit and forbid any printer, bookseller or other person who carries on the book trade to imitate in type, publish, print, or sell when printed elsewhere, the books which the noble Johannes Hevelius has either published heretofore or will publish hereafter, in any type and format whatever, whether whole or any part of them, within the bounds of Our Kingdom and Dominions, for the next twenty-five years, reckoned from the first day of publication, without Hevelius's own, or his heirs' and succes- sors' knowledge and consent — none may dare it — on this added condition, however: that three copies of every book are sent to Our Court. If anyone presumes to transgress and violate this disposition of Ours, it is Our will that he shall not only be deprived of such books, which are to be claimed for the said Johannes Hevelius and his heirs and successors, with the help of the magistrate, wherever they are found, but shall also be fined and punished four hundred Hungarian gold pieces [aureis Vngaricalibus], one half to go to Our Royal revenues and the other half to the same Hevelius or his heirs and successors. We command all courts and offices, and all magistrates whatever established within Our Kingdom and Dominions, ecclesiastical and secular, territorial and municipal [Terreſtribus & Civilibus], not to allow anyone to violate or disregard this Privilege of Ours, but to proceed severely against all contraveners whatever according to the foregoing, and to see to it that proceedings are taken against them and their temerity restrained by every means — as, out of regard for Our favour and the duty of their offices, they will not do otherwise. In witness of this We have ordered these presents, signed by Our hand, to be secured with the Seal of the Kingdom. Given at Warsaw, 1662 February 3, in the 13th year of Our reign in Poland and the 14th in Sweden.

John Casimir, King [Joannes Caſimirus Rex.]

L. S. [the place of the seal]

Stephanus Hankiewic, Secretary of His Royal Majesty [Secretar. Reg. Majeſtat.]

Index of the Books and Order of the Whole Cometographic Work [INDEX LIBRORUM Atque Series totius Operis COMETOGRAPHICI.]

Book One [LIBER PRIMUS]

It contains the observations of the comet of 1652, and the whole calculation by which its apparent motion was investigated, both with respect to its orbit and with respect to the ecliptic and the equator, with a view to the parallaxes and the other matters to be deduced from it.

Book Two [LIBER SECUNDUS,]

It proves from its motion that the comet was ethereal.

Book Three [LIBER TERTIUS,]

It treats of the parallaxes, derived by a cruder method, that follow when the seat of comets is posited in different regions of the air, and it shows that comets move in the highest ether.

Book Four [LIBER QUARTUS,]

It presents the genuine parallaxes of the comet of 1652, vertical as well as horizontal, and also sets out a more accurate method, by which they were determined in this comet and by which they can be investigated exactly in the other comets too.

Book Five [LIBER QUINTUS,]

It discusses the true place of the comet and its distances from the Earth, and proves conclusively that comets are not sublunary but celestial.

Book Six [LIBER SEXTUS,]

It discloses the apparent and the true size of the head and the tail, and the light and colour, both of the comet of the year 1652 and of certain other hairy stars; and it searches out, examines and elucidates all their phenomena, discussing at the same time a great many questions on the same subject.

Book Seven [LIBER SEPTIMUS,]

It sets out at length the author's opinion on the origin, the true matter, the form, the properties and the passing away of the comet of the year 1652 as well as of all other comets.

Book Eight [LIBER OCTAVUS,]

It treats of the tails of comets and of their various phenomena, colour, light and remarkable appearances, and at the same time puts these before the eye, drawn from life.

Book Nine [LIBER NONUS,]

It clearly sets out the motion of comets, both in general and in particular, and the author's whole hypothesis, by which single and fixed hypothesis the course of all comets, the apparent as well as the true, can be successfully defended and preserved, as is amply confirmed there by a great many examples and diagrams.

Book Ten [LIBER DECIMUS,]

It comprises the description of the comet of 1661, and its observations themselves, not only bare but also worked out, as well as its theory.

Book Eleven [LIBER UNDECIMUS,]

It sets the theory of the two more recent comets, namely those of the years 1664 and 1665, quite clearly before the eyes, and fully explains and demonstrates what remained to be said of them after the *Prodromus* and the *Mantissa*.

Book Twelve [LIBER DUODECIMUS,]

It contains the history of all comets, as many as have ever been recorded and observed up to the present by historians, philosophers and astronomers, with the author's notes and remarks.

Annexed to this Twelfth Book is a table presenting all the comets and their principal phenomena in order.

Catalogue of the Authors Mentioned in This Work [Catalogus Auctorum, quorum mentio fit in hoc Opere.]

A.

- Benedictus Accoltus
- Achilles
- Acosta
- Paulus Aemilius
- Aeschylus
- Aimonius
- Albertus, Abbot of Stade
- Albertus Magnus
- Ulisses Aldrovandus
- Alhasen [Ibn al-Haytham]
- Alkindus
- Joh. Henricus Alstedius
- Ambrosius [Ambrose]
- Vitus Amerbachius
- Ammianus
- Anastasius
- Anaxagoras
- English History [Anglica Hiſtoria.]
- Antoninus
- Apollonius Cattus
- Apollonius Myndius
- Petrus Appianus [Peter Apian]
- Franciscus Aguilonius
- Archimedes
- Georgius Areopalita
- Aretius
- Aristoteles [Aristotle]
- Roger Arra

- Artus, of Danzig
- Augustan History [Auguſtana Hiſtoria.]
- Augustinus [Augustine]
- Aversa
- Adrianus Auzoutius

B.

- Balaeus
- Erasmius Bartholinus
- Basilius
- Basirius
- Beda
- Bellutus
- Bergomensis
- Marius Bettinus
- Bizaras
- Josephus Blancanus
- Johannes Bodinus
- Hector Boëtius
- Josephus Bonfilius
- Antonius Bonfinius
- Christophorus Borrus
- Tycho Brahaeus [Tycho Brahe]
- Brengerus
- Brügnerus
- Jordanus Bruno
- Abrahamus Bucholzerus
- Ismaël Bullialdus [Ismaël Boulliau]
- Henricus Bûntingius
- Byzantine History of Ducas [?], grandson of Michael [Byzantina Hiſtoria, Ducis Michaëlis Nepotis.]
- Byzantine History of Georgius Areopalita [Byzantina Hiſtoria Georgii Areopalitæ.]

C.

- Nicolaus Cabaeus
- Aloysius Cadamustus
- Calippus
- Callisthenes
- Sethus Calvisius
- Joachimus Camerarius
- Tommaso Campanella
- Hieronymus Cardanus
- Carion's Chronicle [Carionis Chronicon.]
- Renatus Carthesius [René Descartes]
- Joh. Dominicus Cassinus

- Georgius Cedrenus
- Magdeburg Centuries [Centuriæ Magdeburg.]
- Chalcocondyla Niceph. Cont.
- Charimander
- Chius
- David Christiani
- Scipio Claramontius
- Christophorus Clavius [Christoph Clavius]
- Annals of Colmar [Colmarienſes Annales.]
- Chronological Compilation [Compilatio Chronologica.]
- Annals of Constantinople [Conſtantinopolit. Annales.]
- Nicolaus Copernicus
- Craigius
- Daniel Cramerus
- Albertus Crantzius
- Horatius Crassus
- Creusserus
- Martinus Cromerus
- Petrus Crûgerus
- Joachimus Curaeus
- Cuspinianus
- Cyrillus
- Joh. Bapt. Cysatus
- Adrastus Cyzicenus

D.

- Democritus
- Dio
- Diogenes Laërtius
- Dion Neopolites
- Johannes Dölingius
- Andreas Duditius
- Simeon, Monk of Durham [Simeon Dünelmenſis Monachus.]
- Albertus Dürerus

E.

- Matthias Eberhardus
- Paulus Eberus
- Ecclesiastical History [Eccleſiaſtica Hiſtoria.]
- Henricus Eckstormius
- Laurentius Eichstadius
- Ephorus
- Epitome of the World [Epitome Mundi.]
- Erphesphordiensis, History of the Landgraves of Thuringia
- Erphordiensis
- Euclides [Euclid]

- Eudoxus
- Eutropius

F.

- David Fabricius
- Paulus Fabricius
- *Fasciculus Temporum*
- Fermatius
- Thomas Fienus
- Jacobus Fincelius
- Jacobus Finckius
- Fiornovellus
- Hieronymus Fracastorius [Girolamo Fracastoro]
- Annals of France [Franciæ Annales.]
- Sebastian Franck
- Gemma Frisius
- Otto of Freising [Otto Friſingenſis.]
- Fritzscherus
- David Frôlichius
- Frommius
- Libertus Fromondus
- Bernhardus Fullenius
- Funckius

G.

- Galilaeus Galilaei [Galileo Galilei]
- Robertus Ganguinus
- Gassarus
- Petrus Gassendus [Pierre Gassendi]
- Cornelius Gemma
- German Chronicle [Germanicum Chronicon.]
- Camillus Gloriosus
- Michaël Glycaeus
- Theodorus Graminaeus
- Claudius Grangaeus
- Gregoras
- Gregorius
- Franciscus Grimaldus
- Gualtherus, prelate of York [Gualtherus, Antiſtes Eboracenſ.]
- Guiduccius
- Guilielmus, Prince of Hesse [Guilielmus, Hasſiæ Princeps.]
- Vincentius Guinisius

H.

- Isaacus Habrechtus
- Tadeáš Hájek
- Constantinus Hugenius

- Haly Ben Rhodoan
- Joachimus Hellerus
- Christophorus Helvicus
- Heraclitus
- Joh. Bapt. Herbenstreitus
- David Herlicius
- Hermannus Contractus
- Herodianus
- Hieronymus
- Hipparchus
- Hippocrates Schius
- Hirsau Chronicle [Hirſaugienſe Chronicon.]
- Johannes Hommelius
- Homerus
- C. Julius Hyginus

I.

- Flavius Josephus
- Paulus Jovius
- Franciscus Junctinus
- Joachimus Jungius
- Justinus

K.

- Bartholomaeus Keckermannus
- Johannes Kepplerus [Johannes Kepler]
- Athanasius Kircherus
- Johannes de Kôning

L.

- Paul. Langius, *Chronicon Ziticense*
- Ludovicus Lavvatherus
- Cyprianus Leovitius
- Johannes Levvenklauvv
- Andreas Libavius
- Fortunius Licetus
- Albertus Linemannus [Albert Linemann]
- Severinus Longomontanus
- M. Annaeus Lucanus
- Conradus Lycosthenes

M.

- Michaël Maestlinus [Michael Mästlin]
- Simon Majolus
- Felix Malleolus
- Wilhelmus of Malmesbury [Wilhelmus Malmesburienſis.]
- Cornelius Malvaticaeus
- Marcellinus

- Casparus Marchius
- Marianus, the Scot [Marianus, Scotus.]
- Simon Marius
- Martinengus
- Mastrius
- Franciscus Maurolycus
- Matthias Mechovius
- Matthias Meine, of Danzig
- Philippus Melanchton [Philipp Melanchthon]
- Marinus Mersennus
- Petrus Messias
- Milichius
- Antonius Mizaldus
- Daniel Môglingius
- Ludovicus Molina
- Geminianus Montanarius
- Balthasar Moretus
- Ioh. Bapt. Morinus
- Philippus Mûllerus
- Muslim History [Muſalmanica Hiſtoria.]
- German Chronicle of Henricus Mutius [Henrici Mutii Chronic. Germanic.]
- Claudius Mydorgius

N.

- Iohannes Nauclerus
- Nicephorus
- Ioh. Euseb. Nierembergius
- Augustinus Niphus
- Andreas Nolthius
- Nuremberg Chronicle [Norimbergicum Chronic.]

O.

- Iulius Obsequens
- Elias Olai
- Iohannes de Oppido
- Hieronymus Ornuphrius
- Paulus Orosius

P.

- Palaeologus
- Matthaeus Palmerius
- Pappus of Alexandria [Pappus Alexandrinus.]
- Matthias Paris
- Ignat. Gaston Pardies
- Franciscus Patricius
- Paulus, the Deacon [Paulus, Diaconus.]

- Petrus Petitus
- Casparus Peucerus
- Iohannes Phocylides [Johannes Phocylides Holwarda]
- Georgius Phranza
- Iohannes Pisanus
- Platina
- Plato
- Plautus
- Plinius [Pliny the Elder]
- Plutarchus
- Polish History [Polonica Hiſtoria.]
- Pontanus
- Possidonius
- Iohannes Praetorius
- the Prior of Hexham [Prior Hauguſtaldenſis.]
- Proclus
- Procopius
- Prosperus, Abbot of Prüm [Proſperus, Abbas Prumienſis.]
- Claudius Ptolemy
- Erycius Puteanus
- Pythagoras

Q.

- Iohannes Remus Quietanus

R.

- Iohannes Regiomontanus
- Chronicle of Regino [Reginonis Chronicon.]
- Petrus Resenius
- Franciscus Resta à Talleocotio
- Nicolaus Reusnerus
- Ioach. Georg. Rheticus
- Anton. Maria de Rheita
- Ambrosius Rhodius
- Father Ioh. Bapt. Ricciolus [Giovanni Battista Riccioli]
- Richardus
- German Rhymes [Rithmi Germanici.]
- Rivander
- Robertus
- Aegid. Personer. de Robbervall
- Abrahamus Rockenbachius
- Aelisaeus Rôslerus
- Helisaeus Röslinus
- Christophorus Rothmannus [Christoph Rothmann]

S.

- Aristarchus of Samos [Ariſtarchus Samius.]

- Daniel Sandbech
- Antonius Santutius
- Saxon Chronicle [Saxonicum Chronicon.]
- Iulius Scaliger
- Iosephus Scaliger [Joseph Justus Scaliger]
- Scottish History [Scotica Hiſtoria.]
- Lambertus Schaffnabrug
- Schedelius
- Christophorus Scheinerus
- Wilhelmus Schickardus
- Iohannes Schleidanus
- Iohannes Schosserus
- Seneca
- Sigebertus
- Epitome of Sigfridus, Priest of Meissen [Sigfridi Presbyt. Misnenſ. Epitome.]
- Simeon, Monk of Durham [Simeon, Dunelmenſis Monachus.]
- Simoneta
- Willebrordus Snellius
- M. Franciscus Soares
- Socrates
- Sozomenus
- Cyriacus Spangenberg
- Mirror of History [Speculum Hiſtoricum.]
- Hilarius Spinellus
- Iohannes Spondanus
- Marcus Squarcialupus
- Iohannes Straussius
- Annals of Iohannes Stumphius [Iohannis Stumphii Annales.]
- Georgius Sualbachius
- Suessanus
- Suetonius Tranquillus
- Petrus Surdus
- Garcias Sylva Figeuroês
- Aeneas Sylvius

T.

- C. Cornelius Tacitus
- Adamus Tannerus
- Tassonus
- Bernhardus Telesius
- Tertullianus
- Thales
- Theodoretus
- Theophanes

- Iacob. [?] Aug. Thuanus
- Tiornovellus
- Gregorius Trapezuntius
- Iohannes Trithemius
- Gregorius of Tours [Gregorius Turonenſis.]
- Tyrius

V.

- Ioh. Bapt. Valentinus
- Benedictus Valerius
- Marcus Varro
- Guidus Ubaldus
- Franciscus Baco de Verulamio [Francis Bacon]
- Veruntianus
- Sext. Aurel. Victor
- Vincentius, of the Order of Preachers [Vincentius, Ord. Prædicator.]
- Polydorus Virgilius
- Vitellio
- Ioh. Iuvenal. Ursinius
- Benjamin. Ursinus
- Annals of Ursperg [Annales Urſpurgenſes.]
- the Abbot of Ursperg [Abbas Urſpurgenſis.]

W.

- Bernhardus Waltherus
- Gottifredus Wendelinus [Govaert Wendelen]
- Wernerus
- Wolfius

X.

- Iohannes Xiphilinus

Z.

- Zenon
- Iacobus Zieglerus
- Zeitz Chronicle [Ziticenſe Chronicon.]
- Iohannes Zonaras

Index and Order of the Figures, and the Places Where Each Is to Be Inserted [Index & Series Figurarum, quibus quæque locis inſeri debeant.]

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	B	between pp. 146 and 147		W	between pp. 602 and 603
	C	between pp. 160 and 161		X	between pp. 614 and 615
	D	between pp. 410 and 411		Y	between pp. 616 and 617
	E	between pp. 412 and 413		Z	between pp. 620 and 621
	F	between pp. 414 and 415	Figure	AA	between pp. 624 and 625

Figure	G	between pp. 442 and 443		BB	between pp. 632 and 633
	H	between pp. 444 and 445		CC	between pp. 634 and 635
	I	between pp. 446 and 447		DD	between pp. 636 and 637
	K	between pp. 448 and 449		EE	between pp. 638 and 639
	L	between pp. 452 and 453		FF	between pp. 642 and 643
	M	between pp. 456 and 457		GG	between pp. 670 and 671
Figure	N	between pp. 458 and 459	Figure	HH	between pp. 680 and 681
	O	between pp. 482 and 483		II	between pp. 686 and 687
	P	between pp. 500 and 501		KK	between pp. 708 and 709
	Q	between pp. 502 and 503		LL	between pp. 742 and 743
	R	between pp. 536 and 537		MM	between pp. 746 and 747
	S	between pp. 554 and 555		NN	between pp. 760 and 761
	T	between pp. 572 and 573		OO	between pp. 768 and 769

[Two blocks, left and right of a vertical rule, each line of the page carrying one row of each; no column heads are printed. "Figure" stands only on the rows where the page prints "Figura". In the right block from AA onward the second letter is printed as a small capital.]

To the Man Illustrious in Fame and Most Distinguished in Dignity, Master Johannes Hevelius, Consul of the Renowned Commonwealth of Danzig [VIRO FAMA ILLUSTRI, DIGNITATE AMPLIS. DN. JOH. HEVELIO, INCLYTÆ REIP. GED. CONSULI.]

They say that horrifying Comets portend dire things, blazing portentously with baleful manes. From this they at once announce famine and plagues of every kind, and prophesy wars about to weigh upon so many peoples. But let timid Minds fear the harmless Stars, and tremble, captive to ignorant credulity. Whoever turns the pages of Hevelius's illustrious Monuments, and the Books the ages will carry with mindful praise, will not, indeed, come away without a sacred awe, nor fail, in reverence, to be astonished at the noble Work; yet all the while he will feel his breast touched by no fear to make it tremble, and by no stunned dread. Rather, he will marvel in his mind at the Arts of the stars, and at so many hidden things of the star-bearing Pole laid open; and, having roamed far and wide along the paths of vast Olympus, he will gaze on the silent torches with their flickering fire. Above all he will long to have the Comets, blazing with varied hair, set before his own eyes. Where they take their origin; what feeds such great tresses; by what track their sudden journey is accomplished; and the things that trouble the minds of anxious mortals: all this, brought to light by fortunate diligence, he will read. O breast teeming with Heaven! into which the Cynthian father himself has poured whatever light he had. The eager World applauds these heavenly studies, and looks up to the lofty undertakings of the ethereal Man. They celebrate the divine Acumen of his skilful Genius, to which the starry Hall unfolds its recesses.

They praise the Artist's exact engravings of the Heavens, and all that he has set down in gleaming copper, and his Hand; and whatever, bought with

wakeful care through so many nights, a learned age longed to see come to light. All this presents itself to Your Genius, most great Louis, in reverence for the summit of the Bourbon Throne. Olympus was showing You worthy of so great a gift, Olympus, which delights to move propitiously at Your nod. Your Favour, of course, has long been rousing the Arts that deserve it, and bids them hope for sure Rewards. Mars lifts his laurelled Head in honour, because You shine, fearsome, in Your ancestral Arms, no more than loyal Apollo boasts that You, who revive the gentle Muses with Your calm Light, are his own glory. Hail to Your spirit! Hail, most sacred King, to these prayers! By this path of Heaven the serene Summit is sought! This Virtue once bore Alcides [Hercules] into the shining Stars, and gave such great increase of Praise! He, indeed, was able to overcome the Lion of Nemea: yet he was no less the Leader of the Muses [Aonidum Dux]. And who would have known that he laid low the Nemean Lion, had Calliope not celebrated the splendid deed? He is said, too, to have borne Heaven on his unconquered neck, and to have set the Poles upon his own head. You too, surely, August One, such rare Glory will await; and already the fates are preparing this honour for You. This same Right Hand, which now, devoted, sets forth the Comets alone, relying on Your Auspices, destines for You the immense Orbs of the whole Heaven, and all the Stars, arranged in their own regions. O may the Aether favour these great Undertakings, and rejoice that it is forthwith shaped by this Hand!

Written at Danzig [Scribeb. Gedani]

Joh. Petr. Titius

Johannes Hevelius, Cometography, Book One [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER PRIMUS.]

Section I. General Description of the Comet of the Year 1652 [SECTIO I. Generalis Cometæ anni 1652. deſcriptio.]

In the year of the Christian era 1652, on Friday, December 20 by the Gregorian style, on the evening just before the winter solstice, at about 6^h, with a very clear sky inviting me, I climbed to my astronomical observatory with two companions well practised in observing the stars. My intention was to take, as carefully as I could, various altitudes and azimuths of the fixed stars with our large brass azimuthal instrument [inſtrumento magno noſtro Orichalcico Azimuthali], both in order to work out afterwards the refractions of our horizon at Danzig, and at the same time to examine Tycho Brahe's table of refraction. So I set about this work, and was already observing some altitudes of Palilicium [Aldebaran] and of Canis Minor, which stood around Subsolanus and Hypeurus, when — behold — an unusual and very rare phenomenon, bearing the appearance of a comet, presented itself to our view towards Vulturnus, a little before 7^h, with Palilicium at an altitude of $34^\circ\ 25'\ 30''$ and Orion rising above the horizon. I had been thinking of no such thing, much less expecting it.

[Margin: The comet's first appearance.]

It stood, in fact, not far from the star otherwise named Regel [Rigel], that is, the left foot of Orion, though a little higher and to the right, near a small star of the fifth magnitude in Eridanus that follows two others. Thus at that time it formed a roughly equilateral triangle with the said star Rigel, of the first rank, and with the star of the third magnitude in Eridanus above Orion's foot; and with the two upper stars of the fourth magnitude in Eridanus it made an almost straight line.

[Margin: The comet's position.]

The head was round and of unusual size, appearing hardly any smaller than the full Moon. It stretched out a remarkable and long tail, or beard, of six or seven degrees, towards Orion's belt and towards Subsolanus — turned away, that is, from the Sun — through the said star above Orion's foot, which shone very brightly within it, as far as very nearly the star in the hilt of the sword. The light of the head, however, was pale, and

[Margin: Size and shape.]

partly blunted and less bright, and it looked like the Moon covered by a very thin cloud. The tail had a similar light, though weaker still and thinner, ending in a very fine point.

All of us, therefore, were astonished and struck by a kind of silent amazement. When we first noticed this new spectacle, each asked the other what it could mean there, and what sort of thing it was. My observers, indeed, judged it to be plainly a meteor, some apparition [phaſma] of no importance; I, however, thought it something of a wonderful and celestial nature, and scarcely a meteor. So I had decided to break off the remaining observations of the fixed stars entirely and to devote myself solely to this phenomenon. But my collaborators, since they wholly rejected our opinion and presumed nothing of the kind, pressed me so keenly to continue with energy the work we had undertaken, the sky being so favourable, that I let myself be persuaded, for their sake, to set the phenomenon aside for the time being and to go on attending to the altitudes (and indeed a great many altitudes, 40 in number, of Palilicium and Canis Minor as well as of Pollux and Sirius, were taken at that time); to measure only some distances of the phenomenon and of certain stars, and those with nothing but a smaller radius, because the sextant was not to hand; and to draw with the greatest care its position with respect to the whole constellation of Orion, and its true appearance, as can be seen in the following figure — against every eventuality, since my mind foreboded, and urged on me, that this was something singular and almost divine.

[Margin: Why the comet was not observed accurately on the first day of its appearance.]

At 9^{h} 52^{m} by our clocks, however, with Sirius at an altitude of 11° 40′, I noticed that the phenomenon was moving fairly fast, by its own motion, upward — that is, towards Orion's shield — (although at the same time, by the common motion, it was tending towards its setting), while still remaining in the same straight line with those two stars in Eridanus mentioned above.

Since it now formed a roughly isosceles triangle with Rigel and with the star in Eridanus above Orion's foot, I was made more certain in my opinion. And so, for the reasons given, and also because it constantly cast its tail turned away from the Sun, I did not hesitate to declare boldly that it was a comet and a plainly ethereal body — notwithstanding the argument that it did not spread its light as vividly and brightly as most comets do. I added, moreover, that I already sensed that this phenomenon was directing its course towards the Pleiades and Perseus, and that on the following day it would no longer shine in the place where it shone today, but would appear around Orion's shield. To some, indeed, this may seem to have been pronounced by me too rashly and hastily, and from a single observation at that; but from the straight line along which it continually advanced, from the fast proper motion by which it was carried, and from other circumstances, I could safely predict it.

[Margin: The first, rougher observation.]

[Margin: The comet was carried by its own motion towards the Pleiades.]

I was therefore fully resolved to examine at once, rather more carefully and with larger instruments, both its altitudes and azimuths, together with its transit through the meridian, and its distances from various fixed stars; but I was disappointed in this hope. For clouds, fairly thick, with the Africus blowing, snatched from us the sight of that body (which I certainly regretted all the more, in that, right at the very beginning of its appearance — as I had indeed intended, and as I could also have done excellently, given the clearness of the sky — that phenomenon

I had measured the less) — so that on that first day it was granted us to obtain nothing more than what has been described.

Whether this comet had first risen on this very day, or had appeared on our horizon somewhat earlier, was not at all established at the time. I hold it more certain than certain, however, that on December 16, when I was likewise investigating the refractions by means of the fixed stars from 7^h in the evening until 12^h at night, there was nothing of it at all; nor on the 17th, although the sky was perfectly clear. The 18th and 19th, on the other hand, were completely cloudy, so that I observed nothing whatever. Yet I suspect from its proper motion that the comet could have been seen on our horizon on the 19th, and perhaps even on the 18th, close to the horizon itself; we, however, as we said, first caught sight of it on the 20th.

[Margin: On December 16 and 17 the comet had not yet shone on our horizon.]

[Margin: On what day it first shone at Danzig.]

On the following days, the 21st and 22nd, although I was fully ready to search out this new portent, nothing could be detected, because the sky was completely overcast.

On the 23rd, however, when this phenomenon shone again, I began with every effort to measure its position with quadrants and sextants, as the observations themselves, both of this day and of the following days, amply testify. We

found that this phenomenon had covered a large space by its proper motion, ascending towards Circius or Favonius, and had passed over the equator; it stood, however, a little below Aldebaran and the Pleiades, at a southern latitude of one or two degrees, forming a roughly obtuse-angled scalene triangle. Its tail it stretched out towards about the northern eye of Taurus, pyramidal in the same way as before. Indeed, just as it had been carried with very swift motion during the three preceding days, so, conversely, it was much diminished, both in the size of its body and in the length of its beard.

[Margin: Observation made on the 23rd.]

On December 24 this phenomenon — or rather comet (for it is rightly so called, by reason both of its motion and of its parallax, as well as of its other appearances) — had acquired a northern latitude, and was very close to the Pleiades on their eastern side.

[Margin: Observation of the 24th.]

On the 25th, in turn, no clear sky shone on our horizon. But on the 26th it had climbed higher and higher, forming an almost straight line with the two stars in the left foot of Perseus, except that it seemed to incline a little more towards Aquilo; its distance from the more westerly of them was nearly equal to the distance that the said stars always keep from each other. On the 27th we saw the comet removed a notable distance from these stars in Perseus' foot, gradually heading upward towards the head of Medusa, otherwise Algol. On the 28th it had come closer and closer to the bright star of Medusa, so that on the 29th, at about 4^{h} in the morning, it described an equilateral triangle with the two brighter stars in Medusa's head.

[Margin: The comet formed a straight line with the two stars in Perseus' left foot.]

On the morning of December 30 it made a very close conjunction with the bright star of Medusa, yet in such a way that it stood a little higher, as if hanging over the star. On the morning of the 31st it stood off at a nearly equal interval from Algol and from Perseus' left arm. On January 1 [Calendis Januarii], opening the year of the Christian era 1653, already nearer to that star in the left arm, it appeared, forming an almost right-angled triangle with this star and the bright star of Medusa. On the 2nd, 3rd and 4th it gradually directed its course towards Perseus' left shoulder, yet keeping continually and most strictly to its great circle. On the 5th and 6th the air, filled with very dense murk, shut off from us the view of the phenomenon and of the whole sky. On the 7th it hung very close over Perseus' left shoulder, standing off from the star, on its northern side, by scarcely the space of one diameter. By January 8, heading towards Cassiopeia, it had left the said star somewhat further behind.

[Margin: Conjunction of the comet and the bright star of Medusa.]

Up to this point I not only saw the comet very well with the naked eye, although it had diminished greatly day by day; I also examined, with the utmost and untiring application, spending whole nights mostly without sleep, a great many of its distances from various fixed stars, as well as its altitudes together

with azimuths. For this I used exquisite instruments of proper size, skilfully made of solid metal — above all a sextant, as well as a very large azimuthal quadrant showing single minutes and seconds by tens — and noted at the same time the true time, corrected with the greatest care by the altitudes of other stars. In this way, with God's help, I obtained for the public good a great many most exquisite observations (as may be seen below).

[Margin: Up to when the comet was observed with the naked eye.]

With the Moon waxing and shining, however, on the 9th and 10th, the comet could not be seen with the naked eye, although I strained every nerve at it. Yet on the morning of January 10, with the Moon sinking to its setting, towards Corus, I detected it with the telescope, although in a rather low position and notwithstanding certain exhalations. Afterwards, however, because the Moon was filled with nearly full light, because of the comet's own lower northern position, and because the sky was very often cloudy, nothing more whatever was observed of it by me; and I am fully convinced that not even a trace of it was noticed by others elsewhere.

From the comet's proper motion, therefore, it is clearly evident that it advanced in longitude against the order of the signs, and passed over the equator and the ecliptic at a certain angle of inclination; moreover, that it acquired a large northern latitude; and also — which is well worth noting — that from the first to the last limit of its appearance it traversed at least 65° on a great circle, with a constant and most regular motion. And although at the beginning its motion was much faster, and towards the end slower, it nevertheless always decreased daily in due proportion. In the same way, along with the proper motion itself, the comet diminished from day to day in the size of its head and the length of its tail, as well as in the light and brightness of both.

[Margin: What kind of motion it had.]

These are the things that I gladly wished to relate, briefly and in general, about this phenomenon's first rising and its course, until it withdrew entirely from our sight. More, and more particular, matters will become clear from what follows: namely, how great the comet's daily proper motion was on any given day, not only in its own orbit but also in longitude and latitude; and also how great its parallax was at every time, its true distance from the earth, and the size of its body, together with other matters pertaining to this, as pleasant as they are necessary to know, which are to be drawn from the very sources of the observations and demonstrated by geometrical calculation.

Section II. Observations of the Comet made with the greatest care at Danzig, from 1652 December 20 to 1653 January 8 [SECTIO II. Obſervationes Cometæ Dantiſci Anno 1652, à die 20 Decembris ad diem 8 Januarii usq;, anno 1653, ſummâ curâ peractâ.]

Now that a general description of the comet has been given, it follows that I should present the observations themselves, together with a number of diagrams

[schematismi] carefully drawn at the same time. So that you may be the less confused, my dear lover of astronomy, and so that each item may be set out more briefly, I have entered all the observations in definite tables. Their first column gives the time as noted by the mechanical clock [artificiale horologium]; the second, the altitudes and the versed shadows [umbras verſas], if any were observed; the third, the azimuths of the fixed stars and of the comet; the fourth, the time corrected from the altitudes and azimuths; while the fifth gives the various distances of the comet and the fixed stars (and also other matters most worth noting): both how great they were at any given time, and with which instruments they were obtained. I would have you note, however, that I measured the comet with several instruments.

First, namely, with a certain radius [Radius] about 4 or 5 feet long. This was not because I set much store by it, but because at times, with clouds flying past, no other instrument could serve us at all. Besides, with its help a single observer, alone, is able to take distances; and the matter is dispatched much more quickly, and yet accurately enough, provided due care is applied. Add that the remaining observations, made with sextants, always deserve greater trust if they have also been checked with some radius: for in that way all errors, if any have been committed (as indeed happens at times), are recognized with no trouble.

[Margin: With which instruments the comet was observed?]

Second, with an exquisite brass sextant, accurately divided into single minutes, indeed into half-minutes and their quarters. Because of its moderate size it could conveniently be used at that time in our Uranian observatory [ſpeculâ noſtrâ Uranicâ], together with other instruments.

Third, with our large azimuthal quadrant as well, with which all the altitudes and azimuths of the comet and of the fixed stars were always investigated with the greatest diligence, whenever the clearness of the sky allowed.

Moreover, to the observations themselves we have added special drawings of the phenomenon. In these one sees clearly not only the true position of the comet with respect to the neighbouring stars, but also its genuine shape, both of the head and of the tail, as well as the region and the stars towards which the tail stretched. This is shown best of all in this first observation, made around the comet's first appearance.

At about half past six the comet first shone on us at *c*, extending its tail through *e*, the small star that follows two others (which, because of the smallness of its body and the nearness of the comet, could not be seen at that time), and

[Margin: The earlier observation of the comet.]

the small star *b* above Orion's foot in Eridanus, roughly towards *h*, the uppermost star of the belt. At that time it formed a nearly equilateral triangle with Rigel and with the said star above Orion's foot. The distance between the comet and Rigel was found with the radius to be 3° 7′; between the comet and the star *b*, 3° 25′; and the distance between the fixed stars themselves was 3° 33′.

At 9^h 52^m, however, the comet had already taken up a somewhat higher place, namely *d*; and so that nearer little star also shone out brightly. The tail, though, still passed through the star of Orion's foot in Eridanus, almost as far as the star *f* in the hilt of the sword, towards the middle star of the belt. At that time the comet no longer formed an equilateral triangle but an isosceles one, as we said more fully in the general description of this comet on p. 2, and as can also be seen clearly from the accompanying drawing.

[Margin: The later observation of the comet.]

Diagram. An engraved star chart, framed, filling the lower part of the page. It shows the constellation figure of Orion — head, raised arm, mantle and lion-skin — stippled over its stars, which are drawn as six- and eight-pointed asterisks. At lower right the comet is drawn twice, each time as a bristling round head with a tail; the tail of the upper head runs up and to the left past the belt. Every label printed on the engraving is listed below; none was left unread, though one letter is uncertain.

- ORION. (upper left, over the raised arm): "Orion."
- Prima Cometæ apparitio / Anno 1652. Die 20 Dec. (left, mid-height): "First appearance of the comet, in the year 1652, on December 20."
- [?] (above a large star at the top of the belt): an engraved letter read as either *h* or *b*.
- g (beside the star below it, in the belt)
- f (beside a star on the mantle, right of the belt)
- b (above a star on the comet's tail)
- i (right of a small star at right)
- d (above the upper comet head)
- Hor. 9 52′ (right of the upper head): "9^h 52^m"
- e (above a small star between the two heads)
- Hor: 6 30′. (right of the lower head): "6^h 30^m"
- c (below the lower head)
- a (above the large star at lower centre)
- Regel. (below that star): "Rigel."
- Autor ſculpſit. (lower right, inside the frame): "Engraved by the author."

Observation II of the Comet, made in the evening of 1652 December 23, new style [Cometæ Obſervatio II. Anno 1652, die 23 Decembr. St. n. veſp. peracta.]

Mechanical clock [Horologiō artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
$5^h\ 37^m\ 50^s$	*Aldebaran.* 27° 31′ 0″	78° 26′ east	$5^h\ 46^m\ 21^s$		
$5^h\ 43^m\ 0^s$	*Comet.* 32° 43′ 0″		$5^h\ 51^m\ 33^s$		The sky on this day was troubled by frequent clouds, so that we could not carry out observations as we wished; nevertheless we wrung out a few, though with the greatest labour. Had the sky been wholly favourable, many more observations would certainly have been obtained.
$7^h\ 13^m\ 0^s$	*Comet.* 44° 28′ east	48° 19′ east	$7^h\ 22^m\ 7^s$		
$9^h\ 20^m\ 0^s$			$9^h\ 29^m\ 51^s$	Distance of the comet from Palilicium, by the radius: 320 to 39 parts, or 7° 0′	
$9^h\ 38^m\ 30^s$	*Right shoulder* 39° 5′ 40″	*of Orion.* 31° 25′ east	$9^h\ 47^m\ 46^s$		
$9^h\ 43^m\ 30^s$			$9^h\ 53^m\ 30^s$	Distance of the comet from Palilicium, by the sextant: 6° 55′, but doubtful	At $11^h\ 15^m$ a straight line from the comet to Aldebaran seemed to pass between two small stars.
$9^h\ 51^m\ 0^s$			$10^h\ 1^m\ 0^s$	Distance of the comet from the right shoulder of Orion: 28° 22′, taken with the sextant	
$9^h\ 54^m\ 0^s$	*Rigel* 26° 24′ 0″		$10^h\ 4^m\ 20^s$		At the same time the diameter of the comet, observed several times with the large azimuthal quadrant, was 26′ or 25′. And although the comet had by now greatly diminished, both in its head and its light and in its tail, it was nevertheless still very conspicuous.
$9^h\ 58^m\ 0^s$	*Rigel* 26° 32′ 45″		$10^h\ 9^m\ 45^s$		
$10^h\ 5^m\ 0^s$			$10^h\ 15^m\ 0^s$		

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
10h 11m 0s			10h 21m 0s	Distance of the comet from the northern horn of ♉ [Taurus]: 20° 27′ 0″, sextant	
10h 17m 15s			10h 27m 15s	The same distance: 20° 27′ 30″, sextant	
10h 19m 45s			10h 29m 45s	The same distance taken again: 20° 28′ 15″, sextant	The colour of the head was pale, and overlaid with a livid whiteness; the tail, however, was about 5° long, and it stretched towards the northern eye of Taurus, though showing a rather dark lividness and a feeble light.
10h 25m 0s			10h 35m 0s		
10h 28m 0s			10h 38m 0s	Distance of the comet from Rigel: 31° 38′ 0″, sextant, doubtful	
10h 31m 45s	*Procyon.* 33° 23′ 45″	45° 31′ east	10h 41m 44s		
10h 47m 20s	*Comet.* 50° 43′ 15″	31° 20′ west	10h 57m 20s		
11h 18m 0s	*Comet.* 48° 4′ 45″	42° 14′ west	11h 28m 0s		
11h 23m 30s	*Aldebaran.* 47° 34′ 0″ December 24, morning	33° 25′ west	11h 35m 24s		
12h 0m 20s	*Aldebaran.* 44° 24′ 0″	44° 31′ west	12h 8m 51s		
1h 17m 0s	*Comet.* 33° 36′ 0″	75° 9′ west	1h 27m 30s		
1h 33m 45s	*Comet* 30° 53′ 0″	79° 55′ west	1h 44m 15s		

[Six ruled columns as on the page. ”East” and ”west” render the printed *Or.* and *Occ.* A star's name, set in italic above the figures in its cell, is given at the head of the cell. The words ”Die 24. Decembris man.” run across the altitude,

azimuth and corrected-time columns on the page and are given here in the altitude column. The Notes column is not ruled into rows: each of its four paragraphs is placed in the row beside which it begins, and runs down beside the following rows. In the third row the mark *Or.* ("east") stands in the altitude cell as well as in the azimuth cell, as printed.]

Observation III of the Comet, made in the evening of 1652 December 26, new style [Obſervatio Cometæ III. Anno 1652, die 26 Decembris St. n. peracta veſp.]

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
$8^h\ 43^m\ 45^s$	*Of Palilicium* 48° 7′ east		$8^h\ 26^m\ 52^s$		At about 6 in the evening the comet made an almost straight line with the two fixed stars in the foot of Perseus; yet they were not separated from each other by an entirely equal space. For when the comet was observed more accurately with the naked eye, its centre stood 1/5 less distant from the heel [Calcaneus] than the stars were from each other; so the distance between the comet and the heel was estimated at about 1° 45′, the interval between the heel and the following star of Perseus's left foot being given as 2° 10′.
$8^h\ 53^m\ 15^s$	*Right shoulder* 33° 38′ 45″	*of Orion.* 48° 12′ east	$8^h\ 36^m\ 7^s$		
$9^h\ 5^m\ 0^s$	*Right shoulder* 34° 55′ 15″	*of Orion.*	$8^h\ 48^m\ 10^s$	Distance of the comet from the northern horn of ♉ [Taurus]: 24° 11′ 0″, sextant	
$9^h\ 16^m\ 45^s$	*Same altitude* 36° 10′ 0″		$9^h\ 0^m\ 34^s$	Distance of the comet from Palilicium: 21° 32′ 0″, sextant	

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
9h 20m 0s			9h 3m 49s	Distance of the comet from Palilicium: 21° 32′ 0″, sextant	
9h 31m 0s	*Left shoulder* 38° 34′ 0″	*of Orion,* doubtful	9h 14m 56s	Distance of the comet from the bright star of ♈ [Aries]: 21° 29′ 0″, sextant	
10h 3m 45s	*Left shoulder* 39° 56′ 45″	*of Orion.* 27° 52′ east	9h 46m 15s		
10h 31m 0s			10h 13m 30s	Distance of the comet from Palilicium: 21° 32′ 0″, sextant	At 8h the comet already appeared somewhat higher with respect to those two stars; but because of the comet's excessive altitude, and because of small clouds passing between, we could not observe its altitudes and azimuths.
11h 3m 30s	*Of Procyon* 35° 13′ 0″		10h 46m 47s		
11h 7m 15s	*Same altitude* 35° 31′ 45″	39° 28′ east	10h 50m 6s		
11h 18m 0s			11h 0m 30s	Distance of the comet from Palilicium: 21° 45′, radius, doubtful	

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
11h 27m 0s			11h 9m 30s	Distance of the comet from the bright star of ♈: 21° 35′ 0″, radius, doubtful	The comet's body appeared somewhat smaller; nevertheless its diameter, measured with the help of the large quadrant, still came to 24′ — which hardly anyone will believe.
11h 33m 0s	*Of Procyon* 37° 41′, doubtful		11h 15m 21s		
11h 38m 0s			11h 20m 23s	Distance of the comet from Capella: 23° 22′ 0″, radius, doubtful	
11h 45m 0s			11h 27m 25s		Its tail, somewhat shorter, reached to about those two small stars in the foot of Perseus, or rather passed 1/3° above them — at 9h 50m, that is.
11h 47m 0s			11h 29m 23s	Distance of the comet from the leading Pleiad: 9° 57′, radius	
11h 56m 0s	*Comet* 52° 36′ 30″, 764 parts of the versed shadow	71° 22′ west	11h 78m 22s		

[Six ruled columns as on the page, with the same conventions as the table for Observation II. In the first row the mark *Or.* (”east”) stands in the altitude cell and the azimuth cell is empty; in the third row the azimuth cell carries only the words ”of Orion”, with no figures. In the last row the words ”764 part. umb.

versa" ("764 parts of the versed shadow") run under the altitude and azimuth figures across the column rule; they are given here in the altitude cell. The last row's corrected time is printed "11 78 22", with 78 in the minutes place, and is given as printed[1]. The Notes column is not ruled into rows: each of its four paragraphs is placed in the row beside which it begins.]

Observation IV of the Comet, 1652 December 27, morning [Cometæ Obſervatio IV. Anno 1652, die 27 Decembr. man.]

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the comet and of the fixed stars (° ′ ″)	Azimuths of the comet and of the fixed stars (h m s)	Time corrected from the altitudes (h m s)	Distances of the comet and of the fixed stars	Notes [Animadvertenda.]
$12^h\ 2^m\ 30^s$	*Comet* 51° 36′ 15″	73° 11′ west	$11^h\ 44^m\ 48^s$		
$12^h\ 6^m\ 0^s$	792 parts of the versed shadow		$11^h\ 48^m$ d	Distance of the comet from the northern horn of Taurus: 24° 35′ 0″, radius	With the sky clear on every side, the comet still appeared with a tail, though a very thin one, about 1½° long. Its head was indeed somewhat paler, but it was of conspicuous size.
$12^h\ 8^m\ 15^s$	*Comet* 50° 44′ 0″; 817½ parts of the versed shadow	74° 54′ west	$11^h\ 50^m\ 31^s$		
$1^h\ 6^m\ 0^s$	*Comet* 42° 40′ 30″; 922, direct shadow	87° 52′ west	$12^h\ 48^m$ 15	doubtful	
$1^h\ 13^m\ 30^s$	*Comet.* 41° 27′ 0″; 883½, direct shadow	89° 37′ west	$12^h\ 55^m\ 45^s$		On this day I made no drawing (for I was short of time); but since the clear sky invited it, I observed the comet with a telescope 12 feet long. What its shape was, however, and what worth recording appeared in it, will be told more fully in Book IV, where we have decided to set out certain things specifically about the shape of its body; and its true appearance will be shown there.

[1] a minutes figure above 59 cannot stand; the reading intended is not evident from the page

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the comet and of the fixed stars (° ′ ″)	Azimuths of the comet and of the fixed stars (h m s)	Time corrected from the altitudes (h m s)	Distances of the comet and of the fixed stars	Notes [Animadvertenda.]
1h 26m 0s	*Comet* 39° 53′ 30″; 836, direct shadow	91° 54′ west	1h 8m 15s	doubtful	
1h 42m 30s	*Comet* 37° 27′ 0″; 766, direct shadow	96° 19′ west	1h 24m 45s		
1h 48m 0s			1h 30m 0s	Distance of the comet from the Pleiades: 10° 9′, radius, doubtful	
1h 58m 0s			1h 40m 0s	Distance of the comet from Capella: 23° 23′, radius	
2h 0m 0s			1h 42m 0s	Distance of the comet from Palilicium: 21° 58′, radius, doubtful	
2h 2m 0s	*Of Palilicium* 31° 6′ 0″	72° 42′ west	1h 42m 26s		
2h 5m 0s			1h 46m 0s	Distance of the comet from the northern horn of Taurus: 24° 58′, radius, doubtful	

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the comet and of the fixed stars (° ′ ″)	Azimuths of the comet and of the fixed stars (h m s)	Time corrected from the altitudes (h m s)	Distances of the comet and of the fixed stars	Notes [Animadvertenda.]
$2^h\ 25^m\ 0^s$			$2^h\ 6^m\ 0^s$	Distance of the comet from Palilicium: 22° 5′ 30″, sextant	
$2^h\ 29^m\ 0^s$			$2^h\ 10^m\ 0^s$	Distance of the comet from the northern horn of Taurus: 24° 35′ 45″, sextant	
$2^h\ 37^m\ 15^s$	*Right shoulder* 29° 39′ 0″ west	*of Orion.* 57° 4′	$2^h\ 19^m\ 44^s$		

[Six ruled columns as on the page. ”West” renders the printed *Oc.* and *Occ.* A star's name, set in italic above the figures in its cell, is given at the head of the cell; the words ”part. umb. versa” and ”Umb. recta”, set under the altitude figures and running across the rule into the azimuth column, are given in the altitude cell. The first ruled row carries two clock lines, $12^h\ 2^m\ 30^s$ and $12^h\ 6^m\ 0^s$, given here as two rows; the words ”792 part. umb. versa” stand on the second line, under the altitude figures of the first. The heading of the azimuth column carries the unit line ”Ho. Mi. Se.” (hours, minutes, seconds), as printed, although its cells give degrees and minutes; the unit line of the altitude column is printed ”Gr. Mi. See.”. In the rows for $1^h\ 6^m$ and $1^h\ 26^m$ the word *dub.* (”doubtful”) stands alone in the distance column, with no distance. The Notes column is not ruled into rows: each of its two paragraphs is placed in the row beside which it begins.]

Observation V of the Comet, made on 1652 December 27, new style [Cometæ Observatio V. Anno 1652, die 27 Decembris St. n. peracta.]

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
$4^h\ 59^m\ 30^s$	*Of Palilicium* 22° 24′ 0″	86° 0′ east	$4^h\ 53^m\ 12^s$		
$5^h\ 5^m\ 0^s$	*Of Palilicium* 23° 8′ 0″	84° 52′ east	$4^h\ 58^m\ 15^s$		The comet was indeed decreasing in size, motion and light; yet it remained quite conspicuous. It directed its tail, about 4° long, between the left leg and the two stars in the foot of Perseus. This place lies, as far as could be judged, at 28° 30′ of longitude and 14° 0′ of latitude.
$5^h\ 14^m\ 0^s$	*Of Palilicium* 24° 8′ 0″	83° 38′ east	$5^h\ 7^m\ 5^s$		
$5^h\ 18^m\ 0^s$			$5^h\ 11^m\ 5^s$	The comet and Palilicium under the same vertical circle	
$5^h\ 21^m\ 0^s$	*Comet* 49° 51′ 0″	80° 39′ east	$5^h\ 14^m\ 5^s$		
$5^h\ 26^m\ 0^s$	*Comet* 50° 26′ 30″	79° 58′ east	$5^h\ 19^m\ 1^s$	doubtful	
$5^h\ 31^m\ 0^s$	*Comet* 51° 16′ 0″	78° 55′ east	$5^h\ 23^m\ 58^s$		
$5^h\ 40^m\ 45^s$	*Comet* 52° 24′ 0″	77° 0′ east	$5^h\ 33^m\ 39^s$	doubtful	
$5^h\ 42^m\ 12^s$	*Comet*		$5^h\ 35^m\ 6^s$	Distance between the comet and Capella: 22° 48′, by the sextant	
$5^h\ 45^m\ 16^s$			$5^h\ 38^m\ 10^s$	Distance of the comet from Palilicium: 24° 16′ 30″, sextant	
$5^h\ 47^m\ 0^s$	*Comet* 53° 33′ 30″	75° 14′ east	$5^h\ 40^m\ 48^s$		

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
$5^h\ 53^m\ 33^s$			$5^h\ 46^m\ 27^s$	Distance of the comet from the bright star of ♈ [Aries]: 21° 27′ 30″, sextant	
$5^h\ 57^m\ 30^s$	*Comet* 55° 6′ 0″	72° 19′ east	$5^h\ 50^m\ 9^s$		
$6^h\ 47^m\ 30^s$	*Right shoulder* 19° 20′ 30″	*of Orion.*	$6^h\ 39^m\ 44^s$		
$6^h\ 49^m\ 45^s$	*Same altitude* 19° 41′ 0″	74° 35′ east	$6^h\ 42^m\ 9^s$		
$6^h\ 54^m\ 0^s$	*Same altitude* 20° 18′ 0″		$6^h\ 46^m\ 3.8^s$		
$11^h\ 34^m\ 0^s$	*Of Palilicium* 46° 49′ 45″	36° 24′ west	$11^h\ 25^m\ 20^s$		
$11^h\ 37^m\ 45^s$	*Of Palilicium* 46° 30′ 30″	37° 27′ west	$11^h\ 29^m\ 1^s$		
$11^h\ 45^m\ 0^s$			$11^h\ 36^m\ 16^s$		
$11^h\ 53^m\ 15^s$	*Comet* 51° 52′ 40″	79° 36′ west	$11^h\ 44^m\ 31^s$		

[Six ruled columns as on the page. ”East” and ”west” render the printed *Or.* and *Oc.* A star's name, set in italic above the figures in its cell, is given at the head of the cell. In the row for $5^h\ 42^m\ 12^s$ the word *Cometæ* stands in the altitude cell with no figures, and the azimuth cell is empty. In the row for $6^h\ 47^m\ 30^s$ the words ”Humer. dext. Orion.” run across the rule into the azimuth cell, which carries no figures. In the row for $6^h\ 54^m$ the seconds of the corrected time are printed ”3.8”, with a point between the figures, and are given as printed. In the rows for $5^h\ 26^m$ and $5^h\ 40^m\ 45^s$ the word *dub.* (”doubtful”) stands alone in the distance column, with no distance. The Notes column is not ruled into rows: its one paragraph is placed in the row beside which it begins. After ”dirigebat.” in the note a small mark stands that is not read [?]; the sense does not depend on it.]

Observation VI of the Comet, made on the morning of 1652 December 28, new style [Cometæ Obſervatio VI. Anno 1652, die 28 Decemb. St. n. mane habita.]

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
$12^h\ 1^m\ 15^s$	*Comet* 50° 34′ 10″	81° 37′ west	$11^h\ 52^m\ 31^s$	doubtful	
$12^h\ 22^m\ 30^s$	47° 31′ 40″	86° 25′ west	$12^h\ 13^m\ 46^s$	doubtful	
$1^h\ 10^m\ 0^s$	*Left shoulder*	*of Orion.*	$1^h\ 1^m\ 15^s$	Distance of the comet from the northern horn of ♉ [Taurus]: 26° 33′ 30″, sextant	Clouds sometimes interrupted the observations, so that only a smaller number of distances were taken.
$1^h\ 34^m\ 0^s$	30° 55′ 0″	51° 10′ west	$1^h\ 25^m\ 5^s$		
$1^h\ 40^m\ 0^s$			$1^h\ 31^m\ 10^s$	Distance of the comet from Palilicium: 25° 23′, radius	
$1^h\ 43^m\ 0^s$			$1^h\ 34^m\ 10^s$	Distance of the comet from Palilicium: 25° 23′ 0″, sextant	In the evening we did see the comet with the naked eye; but because the sky was continuously overcast, nothing at all was observed of it with instruments, except the altitude of Palilicium, 28° 34′ 45″, and its azimuth.
$1^h\ 53^m\ 0^s$	*Right shoulder*	*of Orion.*	$1^h\ 44^m\ 10^s$	Distance of the comet from Capella: 22° 52′ 0″, sextant	
$1^h\ 57^m\ 0^s$	32° 47′ 45″		$1^h\ 48^m\ 9^s$		
$1^h\ 59^m\ 0^s$	32° 35′ 45″		$1^h\ 49^m\ 56^s$		
$2^h\ 2^m\ 0^s$			$1^h\ 53^m\ 9^s$	Distance of the comet from the preceding one of the Pleiades: 13° 25′ 0″, radius	

[Six ruled columns as on the page; the azimuth column's unit line reads "Gr.Min." (degrees, minutes). "West" renders the printed *Oc.* A star's name, set in italic above the figures in its cell, is given at the head of the cell. The first ruled row carries two clock lines, given here as two rows. In the rows for $1^h\ 10^m$ and $1^h\ 53^m$ the words "Hum. ſiniſt." / "Hum. dext." stand in the altitude

cell and "Orionis." in the azimuth cell with no figures; the shoulder's figures stand in the next ruled row, below a rule. In the first two rows the word *dub.* ("doubtful") stands alone in the distance column, with no distance. The Notes column is not ruled into rows: each of its two paragraphs is placed in the row beside which it begins. The evening note gives no figure for the azimuth it names. The note prints "altitudo" (nominative) after *præter*; it is rendered "the altitude".]

Observation VII of the Comet, made on the morning of 1652 December 29, new style [Cometæ Obſervatio VII. Anno 1652, die 29 Decembr. St. n. mane habitâ.]

[This heading is printed inside the frame of the table above, in a band across the altitude, azimuth, corrected-time and distance columns; the table below continues that frame and its column heads.]

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
$4^h\ 9^m\ 0^s$	*Comet* 18° 9′ 15″	49° 28′ S.Oc	$3^h\ 50^m\ 52^s$		
$4^h\ 14^m\ 0^s$	17° 22′ 0″	48° 33′ S.Oc	$3^h\ 55^m\ 52^s$		In this observation the comet, because of the thicker air, was very faint; so it was not possible to draw all the observations from the sky with the care that was due. Moreover, because at that time the comet stood in a lower position, and was so dark and pale that the comet itself could barely, if at all, be made out, and the tail not at all.
$4^h\ 21^m\ 40^s$	*Of Capella* 36° 59′ 0″	west	$4^h\ 3^m\ 31^s$		
$4^h\ 24^m\ 0^s$			$4^h\ 5^m\ 50^s$	Distance of the comet from the northern horn of ♉ [Taurus]: 28° 30′, radius	
$4^h\ 29^m\ 0^s$	*Comet*		$4^h\ 10^m\ 50^s$	Distance of the comet from Capella: 22° 46′, sextant	

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes [Animadvertenda.]
$4^h\ 46^m\ 30^s$	$14°\ 26′\ 0″$	$44°\ 23′$ S.Oc	$4^h\ 28^m\ 58^s$	But doubtful, because of the faintness of the light.	Except for one, the distances were observed only with the smaller radius; how much weight they should be given, the calculation will show. The wind was then blowing from the south, and the cold was intense. At that time the comet formed, with the two [stars] in the Head of Medusa, a roughly right-angled triangle; and with the bright [star] of Medusa and the larger one in the foot of Perseus, a nearly straight line.
$4^h\ 53^m\ 0^s$	*Of Capella* $32°\ 58′\ 0″$	west	$4^h\ 35^m\ 52^s$		
$4^h\ 58^m\ 15^s$	$32°\ 11′\ 0″$		$4^h\ 40^m\ 4^s$		
$5^h\ 6^m\ 0^s$	*Comet* $12°\ 7′\ 0″$	$39°\ 28′$ S.Oc	$4^h\ 47^m\ 49^s$	Somewhat more certain.	
$5^h\ 13^m\ 15^s$	*Of Capella* $30°\ 37′\ 45″$		$4^h\ 55^m\ 32^s$		
$5^h\ 29^m\ 0^s$			$5^h\ 10^m\ 40^s$	Distance of the comet from the foot of Perseus: $10°\ 23′$, but doubtful	

[Six ruled columns, continuing the table above. "West" renders the printed *Occid.*, which stands in the azimuth cell with no figures. *S.Oc*, printed without a closing point in all four comet azimuths, is given as printed: the page does not expand it, and its direction is not settled here [?]. In the rows for $4^h\ 9^m/4^h\ 14^m$ and $4^h\ 53^m/4^h\ 58^m\ 15^s$ one ruled row carries two clock lines, given here as two rows. In the row for $4^h\ 29^m$ the word *Cometæ* stands in the altitude cell with no figures; the comet's figures stand in the next ruled row, below a rule. The Notes column is not ruled into rows: each of its two paragraphs is placed in the row beside which it begins. The note prints "circitcr" for *circiter* ("roughly").]

Observation VIII of the Comet, made in the evening of 1652 December 29 [Cometæ Obſervatio VIII. Anno 1652, die 29 Decembr. veſp. habit[[á/á]].]

At about 12 at night I did catch sight of the comet with the naked eye, near the bright star in the Head of Medusa; and as far as could be judged, it stood about 25′ from that star toward the south. It was directing its course as if over the star, yet as though it meant to graze it. In colour it was very pale, and its head had diminished noticeably, nor did its tail appear; but I think this happened chiefly because the air was not clear enough and small clouds were drifting across. For that reason, too, it could not be observed with instruments in any way at all.

Observation IX of the Comet, made on Monday, 1652 December 30, new style [Cometæ Obſervatio IX. Anno 1652, die Lunæ, 30 Decembr. St. n. peracta.]

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$5^h\ 38^m\ 0^s$			$5^h\ 29^m\ 37^s$	Distance of the comet from Palilicium: 31° 45′ 30″, sextant	The head of the comet was much diminished, and its light very weak, so that it could be observed through the sights only with difficulty; nevertheless a tail also appeared, though a shorter one, as can be seen in the drawing of this observation. The comet was directing the tail roughly toward the left knee of Perseus.
$5^h\ 39^m\ 30^s$	*Of Palilicium* 29° 45′ 45″		$5^h\ 31^m\ 7^s$	Distance of the comet from Palilicium: 31° 44′ 30″, sextant	
$6^h\ 19^m\ 0^s$			$6^h\ 10^m\ 30^s$	Distance of the comet from the northern horn of ♉ [Taurus]: 31° 4′ 0″, sextant	
$6^h\ 34^m\ 0^s$			$6^h\ 25^m\ 30^s$		
$6^h\ 50^m\ 30^s$			$6^h\ 41^m\ 50^s$	Distance of the comet from Capella: 23° 27′ 0″, sextant	The altitudes and azimuths of this comet could not be recorded with the instruments, because of its excessive elevation.

Mechanical clock [Horologium artificiale.] (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$6^h\ 55^m\ 0^s$	*Northern horn of* ♉ *[Taurus]* 43° 26′ 30″	east	$6^h\ 46^m\ 6^s$	Distance of the comet from Palilicium: 31° 42′, radius	
$7^h\ 0^m\ 0^s$	*Of Palilicium*		$6^h\ 51^m\ 10^s$		
$7^h\ 3^m\ 15^s$	40° 43′ 30″	54° 10′ M.Or.	$6^h\ 54^m\ 29^s$		
$7^h\ 6^m\ 35^s$	41° 4′ 0″	53° 22′ M.Or.	$6^h\ 57^m\ 24^s$		
$9^h\ 0^m\ 0^s$			$8^h\ 50^m\ 49^s$	Distance of the comet from the preceding one of the Pleiades: 19° 54′, radius	

[Six ruled columns as on the page; the notes column carries no heading here, and "Notes" is supplied from the column's place in the earlier tables. "East" renders the printed *Orient.*, which stands in the azimuth cell with no figures. *M.Or.*, set small after the two azimuths, is given as printed: the page does not expand it [?]. In the row for $7^h\ 0^m$ the word *Palilicii* stands in the altitude cell with no figures; the star's figures stand in the next ruled row, which carries two clock lines, given here as two rows. The Notes column is not ruled into rows: each of its two paragraphs is placed in the row beside which it begins. The drawing named in the first note is not on this page.]

Observation X of the Comet, made on Tuesday, 1652 December 31, new style [Cometæ Obſervatio X. Anno 1652, die Martis, 31 Decembr. St. n. habita.]

[This heading is printed inside the frame of the table above, in a band across the altitude, azimuth, corrected-time and distance columns; below it the unit line alone is printed again, and the table continues the column heads of the table above.]

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$3^h\ 35^m\ 0^s$	☉ *Procyon* 31° 11′ 45″	50° 47′ M.Oc.	$3^h\ 25^m\ 35^s$		The sky was indeed completely clear; but because of the comet's lower position it appeared very pale, and this time we did not notice its tail.
$3^h\ 39^m\ 30^s$	☉ *Of Procyon* 30° 38′ 45″	52° 2′ M.Oc	$3^h\ 28^m\ 52^s$		
$3^h\ 48^m\ 0^s$	☾ *Comet* 20° 26′ 45″	46° 55′ S.Oc	$3^h\ 37^m\ 26^s$		
$3^h\ 55^m\ 0^s$	☾ *Comet* 19° 44′ 0″	45° 56′ S.Oc	$3^h\ 44^m\ 24^s$		It was also difficult to observe with the instruments, and it was smaller than hitherto. It stood at an equal distance from the bright star of Medusa and from the arm of Perseus, namely at $4^h\ 50^m$ [printed ”4 50′”].
$4^h\ 0^m\ 0^s$			$3^h\ 49^m\ 22^s$	Distance of the comet from Capella: 23° 30′, radius	
$4^h\ 4^m\ 0^s$			$3^h\ 53^m\ 20^s$	Distance of the comet from the northern horn of ♉ [Taurus]: 31° 28′, radius	
$4^h\ 18^m\ 0^s$			$4^h\ 7^m\ 18^s$	Distance of the comet from Capella: 23° 24′ 30″, sextant	
$4^h\ 26^m\ 0^s$			$4^h\ 15^m\ 16^s$	Distance of the comet from the northern horn of ♉ [Taurus]: 31° 25′ 0″, sextant	
$4^h\ 29^m\ 30^s$	☉ *Of Capella* 33° 58′ 0″	57° 17′ S.Oc	$4^h\ 18^m\ 43^s$		
$4^h\ 38^m\ 15^s$	☾ *Comet* 15° 41′ 30″	38° 7′ S.Oc	$4^h\ 27^m\ 22^s$	doubtful	
$4^h\ 44^m\ 0^s$	☉ *Of Capella* 32° 15′ 30″	55° 12′ S.Oc	$4^h\ 33^m\ 0^s$		

[Six ruled columns, continuing the frame of the table above; the column heads are supplied from it, since only the unit line is printed here. *M.Oc.* (with and without a point) and *S.Oc* (without a point) are given as printed: the page does not expand them [?]. In the row for $4^h\ 38^m\ 15^s$ the word *dub.* (”doubtful”) stands alone in the distance column, with no distance. The distance cell of

the last row is not closed by a rule and is empty. The Notes column is not ruled into rows: each of its two paragraphs is placed in the row beside which it begins.]

Observation XI of the Comet, made on the morning of Wednesday, 1653 January 1, new style [Cometæ Obſervatio XI. Anno 1653, die Mercurii, 1. Januarii St. n. mane habita.]

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$2^h\ 11^m\ 30^s$	☉ *Of Palilicium* 25° 16′ 0″	west	$2^h\ 1^m\ 30^s$		
$2^h\ 15^m\ 0^s$	☉ *Of Palilicium* 24° 42′ 40″	west	$2^h\ 5^m\ 3^s$		This observation was made under a very clear sky. The comet was found somewhat brighter than on the previous day; its tail also shone in turn, though very short, and so faint that it scarcely caught the eye.
$2^h\ 25^m\ 40^s$	☾ *Comet* 30° 14′ 0″	57° 58′ *S Oc*	$2^h\ 15^m\ 40^s$		
$2^h\ 30^m\ 45^s$	☾ *Comet* 29° 29′ 45″	56° 50′ *S.Oc*	$2^h\ 20^m\ 43^s$		
$2^h\ 35^m\ 0^s$	☾ *Comet* 28° 58′ 0″	56° 3′ *S.Oc*	$2^h\ 24^m\ 55^s$		Moreover, at $2^h\ 30^m$ [printed ”2 30′”] the comet appeared to lie in a straight line with the arm and the side of Perseus; with the arm and the bright star of Medusa, on the other hand, it formed a roughly right-angled triangle. The ratio of the distances from the fixed stars was double, as the drawing attests.
$2^h\ 38^m\ 15^s$	☉ *Of Palilicium* 21° 22′ 10″		$2^h\ 28^m\ 6^s$		
$2^h\ 44^m\ 30^s$			$2^h\ 34^m\ 20^s$	Distance of the comet from Palilicium: 34° 5′ 0″, sextant	
$3^h\ 3^m\ 0^s$			$2^h\ 52^m\ 49^s$	Distance of the comet from the northern horn of ♉ [Taurus]: 32° 45′ 30″, sextant	

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$3^h\ 14^m\ 0^s$			$3^h\ 3^m\ 48^s$	Distance of the comet from Capella: 23° 54′ 0″, sextant	
$3^h\ 26^m\ 0^s$			$3^h\ 15^m\ 47^s$	Distance of the comet from the bend at the hips of Cassiopeia: 24° 46′ 0″, sextant	
$3^h\ 29^m\ 0^s$	*Right shoulder* 18° 41′ 45″	*of Orion* west	$3^h\ 19^m\ 6^s$		
$3^h\ 32^m\ 10^s$	*The same, alt.* 18° 8′ 0″	west	$3^h\ 23^m\ 4^s$		
$3^h\ 36^m\ 0^s$	*Comet* 21° 57′ 0″	46° 10′ *S.Oc*	$3^h\ 26^m\ 0^s$	Distance of the comet from Palilicium: 34° 0′, radius, doubtful	
$3^h\ 50^m\ 0^s$			$3^h\ 40^m\ 0^s$	Distance of the comet from the northern horn of ♉ [Taurus]: 32° 48′, radius, but doubtful	
$3^h\ 54^m\ 0^s$	*Comet* 20° 4′ 30″	43° 9′ *S.Oc.*	$3^h\ 44^m\ 16^s$		
$3^h\ 56^m\ 40^s$	*Of Capella* 37° 25′ 10″	west	$3^h\ 46^m\ 50^s$	Distance of the comet from Capella: 23° 54′, radius	
$4^h\ 3^m\ 0^s$			$3^h\ 53^m\ 0^s$	Distance of the comet from the bend at the hips of Cassiopeia: 24° 41′, radius	

$4^h\ 4^m\ 30^s$	*Of Capella* 36° 26′ 0″		$3^h\ 54^m\ 36^s$		

[Six ruled columns as on the page, headed in full here; "Notes" renders the printed *Animadvertenda*. "West" renders the printed *Occid.*, which stands in the azimuth cell with no figures. *S Oc* (without a point), *S.Oc* and *S.Oc.* are given as printed; the page does not expand them. In the row for $3^h\ 29^m$ the star's name, *Hum. dext. Orionis* ("right shoulder of Orion"), runs across the altitude and azimuth cells; in the next row *Eadem alt.* ("the same, altitude") stands over the altitude. The distance cell of the last row is not closed by a rule and is empty. The Notes column is not ruled into rows: each of its two paragraphs is placed in the row beside which it begins. The drawing named in the second note is not on this page.]

Observation XII of the Comet, made in the evening of Thursday, 1653 January 2, new style [Cometæ Obſervatio XII. Anno 1653, die Jovis, 2 Januarii St. n. veſp. habita.]

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$5^h\ 45^m\ 15^s$	*Of Palilicium* 33° 4′ 0″	east	$5^h\ 41^m\ 37^s$		Although the sky was at first quite clear, the comet nevertheless could not be observed with the sextant, because of its feeble light, the smallness of its body and the turbulence of the air; the distances were taken with the radius only.
$5^h\ 47^m\ 0^s$	33° 19′ 0″	east	$5^h\ 43^m\ 36^s$		
$5^h\ 56^m\ 0^s$			$5^h\ 53^m\ 30^s$	Distance of the comet from the bright star in the side of Perseus: 6° 27′, radius	
$6^h\ 11^m\ 0^s$			$6^h\ 7^m\ 30^s$	Distance of the comet from the bright star of Medusa: 4° 52′, radius	
$6^h\ 20^m\ 0^s$			$6^h\ 16^m\ 30^s$		This time we did not see the tail. But the diameter of the body was estimated at 7′ or 8′, so that it displayed a notable size; because of its very feeble light, however, it was hardly conspicuous.

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$6^h\ 31^m\ 0^s$			$6^h\ 27^m\ 30^s$	Distance of the comet from the left knee of Perseus: 12° 31′, radius	
$6^h\ 58^m\ 0^s$			$6^h\ 54^m\ 30^s$	Distance of the comet from Capella: 24° 22′, radius	
$7^h\ 4^m\ 30^s$	*Northern horn of* ♉ *[Taurus]* 47° 22′ 0″	east	$7^h\ 0^m\ 46^s$		With the bright star of Medusa and the shoulder of Perseus it formed an almost straight line.
$7^h\ 7^m\ 0^s$	47° 46′ 15″	70° 45′ *M.Or.*	$7^h\ 3^m\ 39^s$		

[Six ruled columns as on the page, headed in full here; "Notes" renders the printed *Animadvertenda*. "East" renders the printed *Orient.*, which stands in the azimuth cell with no figures. *M.Or.* is given as printed; the page does not expand it. The first ruled row carries two clock lines and two altitudes under the one name *Palilicii*, given here as two rows. In the last row the altitude stands under no name, in the ruled row below that of the northern horn of Taurus. The Notes column is not ruled into rows: each of its three paragraphs is placed in the row beside which it begins.]

Observation XIII of the Comet, made on Friday, 1653 January 3, new style [Cometæ Obſervatio XIII. Anno 1653, die Veneris, 3 Januarii St. n. peracta.]

[This heading is printed inside the frame of the table above, in a band across the altitude, azimuth, corrected-time and distance columns; below it the unit line alone is printed again, and the table continues the column heads of the table above.]

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$6^h\ 16^m\ 0^s$	*Right shoulder* 20° 36′ 15″	*of Orion* 73° 5′ *M.Or.*	$6^h\ 18^m\ 44^s$	Distance of the comet from Capella: 24° 45′, radius	Although the sky was quite cloudless, the comet's excessive altitude nevertheless made it hard work to examine its intervals from the stars. Hence the distances were observed with the radius alone, and indeed with as much care as that instrument allowed.
$6^h\ 39^m\ 0^s$	*The same, altitude* 23° 31′ 50″		$6^h\ 40^m\ 6^s$	Distance of the comet from the bright star in the side of Perseus: 6° 1′, radius	
$6^h\ 47^m\ 0^s$			$6^h\ 47^m\ 30^s$	Distance of the comet from the bright star of Medusa: 6° 45′, radius	
$6^h\ 50^m\ 30^s$	*Northern horn of* ♉ *[Taurus]* 46° 37′ 30″	72° 55′ *Or.*	$6^h\ 50^m\ 58^s$		
$6^h\ 56^m\ 0^s$			$6^h\ 56^m\ 0^s$	Distance of the comet from the northern horn of Taurus: 35° 15′, radius	In turn, we saw the tail clearly; as far as could be judged, it extended toward the bend of the left side of Perseus.
$7^h\ 0^m\ 0^s$			$6^h\ 59^m\ 50^s$	Distance of the comet from Palilicium: 37° 34′ [printed ”37 34”], radius, but doubtful	
$7^h\ 18^m\ 0^s$	*Northern horn of* ♉ *[Taurus]* 50° 17′ 40″	66° 5′ *Or*	$7^h\ 17^m\ 42^s$		The comet formed something like an equilateral triangle with the bright star of Medusa and the bright side of Perseus.
$7^h\ 59^m\ 0^s$	*Of Procyon* 19° 1′ 20″	73° 17′ *Or*	$7^h\ 58^m\ 12^s$		
$11^h\ 4^m\ 15^s$	*Of Palilicium* 46° 2′ 10″	39° 20′ *Oc.*	$11^h\ 3^m\ 17^s$		
$11^h\ 9^m\ 0^s$	*Of Palilicium* 45° 37′ 45″	40° 41′ *Oc.*	$11^h\ 7^m\ 43^s$		

[Six ruled columns, continuing the frame of the table above; the column heads are supplied from it, since only the unit line is printed here. In the first row the star's name, *Humer. dext. Orion.* ("right shoulder of Orion"), runs across the altitude and azimuth cells. *M.Or.*, *Or.*, *Or* and *Oc.* are given as printed; the page does not expand them. In the row for 7^h 0^m the distance is printed without degree or minute marks. The Notes column is not ruled into rows: each of its three paragraphs is placed in the row beside which it begins.]

Observation XIV of the Comet, made on Saturday, 1653 January 4, new style [Cometæ Obſervatio XIV. Anno 1653, die Saturni, 4. Januarii St. n. habita.]

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
1^h 55^m 0^s	*Of Palilicium*		1^h 51^m 24^s	Distance of the comet from Palilicium: 37° 57′, sextant	
1^h 57^m 0^s	24° 30′ 45″	west	1^h 53^m 24^s		After eleven in the evening clouds came over, and so put an end to the observation on that occasion. At 2^h, however, the sky shone clear again, so that the comet could once more be observed with the sextant, even though its tail did not appear as clearly as on the previous evening.
2^h 7^m 0^s			2^h 3^m 24^s	Distance of the comet from Capella: 25° 18′ 30″, sextant	
2^h 13^m 0^s			2^h 9^m 24^s	The same distance: 25° 18′ 0″, radius	
2^h 14^m 0^s	*Of Palilicium*		2^h 10^m 24^s	Distance of the comet from Palilicium: 38° 0′, radius	
2^h 19^m 0^s	21° 17′ 45″	west	2^h 15^m 24^s		

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$2^h\ 30^m\ 30^s$			$2^h\ 26^m\ 54^s$	Distance of the comet from the bend at the hips of Cassiopeia: 20° 48′ 30″, sextant	
$2^h\ 35^m\ 30^s$	*Of Capella* 45° 39′ 30″	west	$2^h\ 32^m\ 6^s$		
$2^h\ 42^m\ 30^s$	*Comet* 26° 42′ 15″	46° 37′ *S.Oc*	$2^h\ 39^m\ 10^s$		
$2^h\ 56^m\ 30^s$	24° 57′ 0″	45° 13′ *S.Oc*	$2^h\ 53^m\ 30^s$		
$3^h\ 2^m\ 30^s$	*Of Capella* 41° 58′ 30″	66° 46′ *S.Oc*	$2^h\ 59^m\ 6^s$		
$3^h\ 7^m\ 0^s$	41° 23′ 40″	west	$2^h\ 4^m\ 11^s$		

[Six ruled columns as on the page, headed in full here; ”Notes” renders the printed *Animadvertenda*. ”West” renders the printed *Occid.*, which stands in the azimuth cell with no figures. *S.Oc* is given as printed; the page does not expand it. In the rows for $1^h\ 55^m$ and $2^h\ 14^m$ the name *Palilicii* stands alone in the altitude cell, and the altitude figures follow in the next ruled row, against their own clock time. The last two ruled rows each carry two clock lines under one star name, given here as two rows. In the last row the corrected time is printed ”2 4 11” against a clock time of $3^h\ 7^m\ 0^s$, after $2^h\ 59^m\ 6^s$ in the row above; it is given as printed. The Notes column is not ruled into rows: its paragraph is placed in the row beside which it begins.]

Observation XV of the Comet, made on Tuesday, 1653 January 7, new style [Cometæ Obſervatio XV. Anno 1653, die Martis, 7 Januarii St. n: peracta.]

[This heading is printed inside the frame of the table above, in a band across the altitude, azimuth, corrected-time and distance columns; below it the unit line alone is printed again, and the table continues the column heads of the table above.]

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
1h 31m 0s	*Of Palilicium* 27° 21′ 0″	west	1h 20m 38s		On this day clouds ran across very often, so that the comet's tail could not be made out distinctly. The body, too, looked very slender and thinned, and its light very pale, so that I could scarcely detect it through the sights [pinnacidia], and even then with great labour.
1h 33m 0s	27° 1′ 0″	west	1h 22m 46s		
1h 53m 0s			1h 42m 46s	Distance of the comet from Capella: 25° 46′, radius	
2h 26m 15s	*Bright star in the side* 33° 44′ 0″	*of Perseus* west	2h 15m 54s	Distance of the comet from the bend at the hips of Cassiopeia: 18° 38′, radius, doubtful	It should be noted that on the previous evening, with the Moon shining, we could in no way make out the comet with the naked eye. The chief reason was that at that time it clung so closely to the star in the left shoulder of Perseus that the comet could by no means be told apart from it. On the 7th, however, in the morning at about 3h, with the Moon absent, it appeared clearly enough again, though deprived of its tail, not far from that star: removed from it by about 5′, or to the eye by two digits, or by a whole diameter of the comet, as far as could be judged.
2h 36m 30s			2h 26m 9s	Distance of the comet from the bright star in the foot of Perseus: 22° 0′, radius	
2h 40m 45s	*Left shoulder* 27° 15′ 45″	*of Perseus* 44° 37′ S.Oc.			
2h 50m 0s	*Comet* 25° 36′ 0″	42° 8′ S.Oc.	2h 41m 0s	doubtful	

Mechanical clock (h m s)	Altitudes of the fixed stars and of the comet (° ′ ″)	Azimuths of the fixed stars and of the comet (° ′)	Time corrected from the altitudes (h m s)	Distances of the fixed stars and of the comet	Notes
$3^h\ 2^m\ 0^s$	*Of Capella* 41° 1′ 0″	65° 39′ *S.Oc*	$2^h\ 53^m\ 2^s$	Distance of the comet from the Pole Star: 39° 45′, radius, approximately	
$3^h\ 17^m\ 0^s$			$3^h\ 8^m\ 0^s$	Distance of the comet from the bend at the hips of Cassiopeia: 18° 42′, sextant	
$3^h\ 25^m\ 15^s$	*Of Capella* 37° 57′ 0″	west	$3^h\ 16^m\ 23^s$		
$3^h\ 45^m\ 45^s$	35° 22′ 0″	58° 58′	$3^h\ 36^m\ 44^s$		

[Six ruled columns, continuing the frame of the table above; the column heads are supplied from it, since only the unit line is printed here. In the rows for $2^h\ 26^m\ 15^s$ and $2^h\ 40^m\ 45^s$ the star's name, *Lucid.later. Perſei.* (”bright star in the side of Perseus”) and *Humer. ſin. Perſei.* (”left shoulder of Perseus”), runs across the altitude and azimuth cells. In the row for $2^h\ 40^m\ 45^s$ the corrected-time and distance cells are empty. In the row for $2^h\ 50^m$ the distance cell carries only *dub.* (”doubtful”), with no figures. The last ruled row carries two clock lines under one star name, given here as two rows; its second azimuth, 58° 58′, has no direction word. *S.Oc* and *S.Oc.* are given as printed; the page does not expand them. The Notes column is not ruled into rows: each of its two paragraphs is placed in the row beside which it begins.]

Observation XVI of the Comet [Cometæ Obſervatio XVI.]

On the morning of January 8 we could not observe the comet, because the sky was turbid and very dense clouds veiled it continually; it was nevertheless drawn. It stood a little more than one degree, or about 1° 10′, from that star

in the left shoulder of Perseus, as far as could be estimated. It was, moreover, very slender and feeble in light, so that it almost escaped sight: it was scarcely farther from the star just mentioned than those three in the belt of Perseus are from one another.

In the evening, however, with the Moon shining, the comet could not be seen; and then through the whole of the following night nothing at all was observed, because of continuous darkness.

On January 9, in the evening, at about 6, 7, 8 and 9 o'clock, the Moon for its part being very clear, we went to search for the comet carefully and with the greatest diligence, with the naked eye. Nevertheless we did not notice even a trace of it, although I knew perfectly well in what place it lay and where it was to be sought.

[Margin: The comet no longer seen with the naked eye.]

On January 10, however, at 4, 5 and 6 o'clock in the morning, with the Moon now setting and below the horizon, I again took the greatest pains to make out the comet; but it was sought in vain with the naked eye. I therefore turned on it an eye armed with a telescope, and this task at last succeeded, though not without great fatigue of the eye. And so I did indeed still detect it, but so diminished in body and so feeble in light that it was seen only with great trouble. In size, however, it still nearly equalled a star of the first or second rank [honoris]; but its light appeared much feebler, like that of some nebulous little star. Hence it came about that it was observed, and its place determined, only with great difficulty, and much less could it be drawn. I searched for it again a second time; but because of its rather low northern position, the very many exhalations, and also the presence of the Moon, I could in no way find the comet, however much I strained every nerve of my eyes on it. I am therefore seriously persuaded that it was seen for the last time on this day, and that afterwards it was observed by no one any more: just as it did not appear anywhere to me either, on January 11.

[Margin: Disappearance of the comet.]

Most of the observers saw this phenomenon only up to January 2 and 3; scarcely one or two noted anything of it on the sixth; but on January 9 and 10 no one at all, as far as I have learned so far, noticed it.

[Margin: No one except the author observed the comet up to January 11.]

This came about, I think, because most of them went to search for the comet in the evening hours, and indeed while the Moon was waxing and above the horizon; at that time, as can certainly be seen from my observations, it could by no means be detected. But if they had made observations diligently in the morning hours, especially those who excelled others in keenness of sight, I do not doubt that they would, like me, have seen distinctly not only its body but its tail too. Some observers are indeed found who say that it had scarcely a trace of a tail; but they err on this point, although it may well have seemed entirely so to them, or rather they imagined it to have been so. But what the reason for this is, and why not each and every one who devoted effort to this

comet judged its head, and its tail, to be equally large, will become sufficiently clear below, in its proper place, where its size and true appearance, and its tail as well, are treated expressly.

Section III. Inquiry into the True Time of Each Observation [SECTIO III. Inquiſitio veri temporis ad ſingulas Obſervationes.]

Now that we have set out the observations we made of this comet, with the favour of the Divine Power, we shall proceed rightly and in order if we go on to examine each and every one of them with the greatest care, and as accurately as possible. For if we wished to rest content with the bare observations, as usually happens, we would indeed satisfy historians, and those who delight only in a superficial historical account; but in no way would we satisfy philosophers and astronomers. Such observations are, indeed, to be made chiefly for this purpose: that by their aid the true place of the comet, its distance from the earth, its size and other things of this kind, as pleasant as they are necessary to know, may be rightly investigated and brought to the knowledge of all. This, certainly, is not so easily gained from the observations alone, however diligent; rather, it is a task of arduous effort to penetrate all these matters thoroughly, and at the same time to remove root and branch the doubts that can be raised.

[Margin: For what purpose observations of comets are to be made.]

We have therefore resolved to examine this comet carefully and to the best of our powers, and to pass over nothing that will seem to bear on a rigorous examination. We shall also take diligent pains to set the matter clearly before the eyes, so that even those who have scarcely greeted astronomy from the threshold may fully recognize that everything has been duly and accurately investigated and set out. Beginners, moreover, are to have a method to which they may safely hold in the same way in future with phenomena of this kind. Accordingly, in unravelling this comet, so that it may be plain by what route each point was investigated, we shall also add the calculation itself, derived from the true foundations of trigonometry; and we shall likewise give ready rules for how it is to be carried out concisely by logarithms. In this way it will at the same time be easy for anyone — since the matter is of great importance — to put my calculation back on the anvil the more readily, and to examine it rigorously.

[Margin: The author's purpose is set out.]

Before we come to the calculation itself, however, it is useful to state at what elevation of the pole [Elevatio Poli] these observations were made, since this is the basis and foundation on which everything must be built. Our Danzig elevation of the pole, then, was found to be 54° 23′ in 1612 by the distinguished Petro Crûgero [Peter Crüger], Professor of Mathematics at our Gymnasium and formerly my teacher, whose memory is always to be honoured with gratitude. We too have always used it, especially where we were content with whole minutes; but when greater precision was needed, our own elevation of the pole, namely 54° 22′ 52″, which with the greatest diligence, as

[Margin: The elevation of the pole at Danzig.]

will be evident from our *Machina coelestis* [Machinâ noſtrâ cœleſti], soon to be published, we ourselves drew from the sky — that is what we used. The true elevation of the equator therefore comes out at 35° 37′ 8″. At times, though, before I had settled anything certain on this matter for myself, I also applied to the calculation an elevation of the pole of 54° 22′ 50″, that is, 2″ less, and an elevation of the equator of 35° 37′ 10″. These two seconds, however, detract nothing at all from our calculation, much less harm it. Nor would it have mattered much to mention this, had I not done so for the sake of those who may perhaps weigh our calculations rather more precisely, so that this variation of no importance may not stand in their way.

As for the obliquity of the ecliptic [Obliquitatem Eclipticæ], we have used not that of Tycho Brahe, 23° 31′ 30″, as being too large — as we have learned from reliable observations, and as has been sufficiently stated and demonstrated elsewhere — but that of Gothofredi Wendelini [Govaert Wendelen], namely 23° 30′ 16″, as truer and more consistent with the observations. Our own value, found later, together with that of the most learned Father Riccioli [Giovanni Battista Riccioli], also nearly agrees with it, apart from a very few seconds. We thought it worth pointing this out at this place, my reader, so that you would not be unaware of it.

[Margin: Which obliquity of the ecliptic was used in the calculation.]

Moreover, it will also not be out of place to enter in a table the declinations, right ascensions [Aſcenſiones Rectas], longitudes and latitudes of the fixed stars that we observed and that are also to be subjected to the following calculation, computed from Tycho's sources for the completed year 1652, so that the calculations may afterwards be carried out the more successfully. But how they were derived by logarithms I refrain from saying on this occasion, for brevity's sake. In that table you will find a double declination, right ascension, longitude and latitude of Palilicium. The second of these, drawn with the greatest care from my own observations, we have used for investigating finer matters; the first, Tycho's, we have used only for working out the true time (a task to which so slight a difference does no harm at all).

In addition, we thought it right to set out first two other tables, very useful for the following calculation; in them are entered, for all the observations we made, the true longitudes of the Sun together with its corresponding right ascensions. In the first table, one column shows the uncorrected time by the mechanical clock; the second column, the true place of the Sun; and the third, the right ascension of the Sun. In this table, however, the longitudes of the Sun have not been computed for each individual moment of time — nor is that needed in such a task. In the second table, by contrast, both the individual longitudes of the Sun and the right ascensions, for the true time corrected from the altitudes, have been worked out with the greatest industry from the Rudolphine Tables [Tabulis Rudolphinis] themselves, or rather from the reformed Rudolphine Tables, that is, the Danzig Tables; likewise so that the calculation of the comet

may be carried out the more readily. The method of calculation, since it is well enough known to students of astronomy, I pass over here to save time; meanwhile, however, it is not difficult for anyone to whom it matters, provided they do not grudge the time, to examine all of it.

[Margin: The place of the Sun computed from the Danzig Tables.]

A small table containing, according to Tycho, the declinations, right ascensions, longitudes and latitudes of the same fixed stars that we used in observing this comet and in calculating it.

Names of the fixed stars [Nomina Stellarum fixarum.]	Declination (° ′ ″)	Right ascension (° ′ ″)	Longitude (° ′ ″, sign)	Latitude (° ′ ″)
Aldebaran, or Palilicium	15° 47′ 0″ N	64° 2′ 0″	4° 56′ 42″ ♊	5° 29′ 37″ S
Aldebaran, or Palilicium, according to our observations	15° 46′ 12″ N	64° 1′ 45″	4° 57′ 8″ ♊	5° 29′ 57″ S
The upper horn of ♉, or the star shared with the right foot of Auriga	28° 16′ 30″ N	76° 6′ 35″	17° 43′ 42″ ♊	5° 20′ 30″ N
The preceding star of the Pleiades, or the one at the tip toward the east			25° 31′ 12″ ♉	3° 55′ 30″ N
The bright star of Aries	21° 49′ 0″ N	26° 57′ 0″	2° 49′ 57″ ♉	9° 57′ 30″ N
The first star of Aries	17° 35′ 0″ N	23° 39′ 0″	28° 21′ 0″ ♈	7° 9′ 8″ N
The right shoulder of Orion, the ruddy or bright one	7° 18′ 20″ N	84° 8′ 30″	23° 56′ 12″ ♊	16° 5′ 30″ S
The left shoulder, or the preceding one	5° 59′ 40″ N	76° 42′ 0″	16° 7′ 12″ ♊	16° 52′ 30″ S
Regel, or the bright star in the left foot of Orion	8° 37′ 48″ S	74° 32′ 0″	12° 1′ 12″ ♊	31° 10′ 40″ S
In the left heel of Perseus	31° 7′ 38″ N	50° 39′ 37″	26° 17′ 12″ ♉	12° 8′ 0″ N
Above the foot of Orion, in Eridanus	5° 33′ 8″ S, according to our observation		10° 26′ 12″ ♊	27° 54′ 0″ S
In the hilt of Orion's sword			15° 21′ 42″ ♊	25° 36′ 30″ S
The following one of two others, in Eridanus			8° 23′ 12″ ♊	29° 51′ 30″ S
The preceding one in Eridanus			6° 13′ 42″ ♊	27° 51′ 0″ S
The following one of the two above			4° 29′ 42″ ♊	25° 34′ 0″ S
Procyon, in the thigh of Canis Minor	6° 6′ 0″ N	110° 19′ 0″	21° 2′ 30″ ♋	15° 56′ 30″ S
Capella, shining in the left shoulder of Erichthonius	45° 35′ 30″ N	72° 46′ 0″	17° 0′ 12″ ♊	22° 52′ 15″ N
The bright or shining star in the right side of Perseus	48° 37′ 30″ N	43° 30′ 0″	27° 1′ 12″ ♉	30° 5′ 30″ N
The bright star of Medusa, or Algol	39° 35′ 0″ N	41° 23′ 0″	21° 21′ 0″ ♉	22° 22′ 30″ N
The preceding star below Algol			20° 2′ 0″ ♉	20° 33′ 30″ N

Names of the fixed stars [Nomina Stellarum fixarum.]	Declination (° ′ ″)	Right ascension (° ′ ″)	Longitude (° ′ ″, sign)	Latitude (° ′ ″)
In the left knee of Perseus			0° 52′ 0″ ♊	19° 4′ 0″ N
The following star of the left foot of Perseus			28° 20′ 12″ ♉	11° 18′ 0″ N
The bright star of Cassiopeia's Chair			0° 19′ 42″ ♉	51° 15′ 0″ N
In the bend at Cassiopeia's hips	58° 51′ 0″ N	9° 6′ 0″	9° 11′ 42″ ♉	48° 46′ 30″ N
The Pole Star	87° 27′ 33″ N		23° 46′ 42″ ♊	66° 2′ 0″ N

2

True longitudes and right ascensions of the Sun, for working out the true time from the altitudes of the fixed stars.

1652 December, day	By the mechanical clock, uncorrected (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
20	$6^h\ 30^m\ 0^s$ evening		
	$9^h\ 52^m\ 0^s$ evening		
23	$5^h\ 37^m\ 50^s$ evening	2° 40′ 0″ ♐	272° 54′ 12″
	$9^h\ 38^m\ 30^s$ evening	2° 51′ 0″ ♐	273° 6′ 30″
	$10^h\ 31^m\ 45^s$ evening	2° 53′ 0″	273° 8′ 41″
	$11^h\ 23^m\ 30^s$ evening	2° 53′ 0″	273° 8′ 41″
	$12^h\ 0^m\ 20^s$ evening	2° 55′ 0″ ♐	273° 10′ 52″
26	$8^h\ 43^m\ 45^s$ evening	5° 51′ 0″	276° 22′ 32″
	$8^h\ 53^m\ 15^s$ evening	5° 51′ 35″	276° 23′ 0″

3

Table showing the true place and right ascension of the Sun, computed from the Rudolphine Tables.

1652 December, day	By the clock, corrected from the altitudes of the stars (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
20	$7^h\ 0^m\ 0^s$ evening	29° 39′ 12″ ♐	269° 37′ 18″
23	$7^h\ 22^m\ 7^s$ evening	2° 44′ 3″ ♐	272° 58′ 55″
	$10^h\ 15^m\ 0^s$ evening	2° 51′ 25″	273° 6′ 58″
23	$10^h\ 57^m\ 20^s$ evening	2° 53′ 14″ ♐	273° 8′ 57″
	$11^h\ 28^m\ 0^s$ evening	2° 54′ 31″	27[?]° 10′ 21″

[2] the table prints the direction of each declination and latitude as *B.* or *Bor.* (north) and *A.* or *Auſt.* (south); these are given here as N and S. Empty cells are empty on the page. "The bright star of Aries" and "The first star of Aries" share one ruled row on the page.

[3] the figure lines are ruled into three groups of three, after the third and the sixth line. The day numbers and the sign ♐ stand only where shown.

1652 December, day	By the clock, corrected from the altitudes of the stars (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
24	$1^h\ 27^m\ 30^s$ morning	2° 59′ 36″	273° 15′ 54″
24	$1^h\ 44^m\ 15^s$ morning	3° 0′ 20″ ♑	273° 16′ 42″
26	$6^h\ 0^m\ 0^s$ evening	5° 44′ 30″	276° 15′ 17″
	$9^h\ 0^m\ 34^s$ evening	5° 52′ 10″	276° 23′ 48″

4

True longitudes and right ascensions of the Sun, for working out the true time from the altitudes of the fixed stars.

1652 December, day	By the mechanical clock, uncorrected (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
26	$9^h\ 5^m\ 0^s$ evening	5° 51′ 35″ ♑	276° 23′ 0″
	$9^h\ 16^m\ 45^s$ evening	5° 52′ 0″	276° 24′ 43″
	$9^h\ 31^m\ 0^s$ evening	5° 53′ 0″	276° 25′ 0″
	$10^h\ 3^m\ 45^s$ evening	5° 54′ 30″ ♑	276° 25′ 0″
	$11^h\ 3^m\ 30^s$ evening	5° 57′ 0″	276° 29′ 0″
	$11^h\ 7^m\ 15^s$ evening	5° 57′ 0″	276° 29′ 0″
	$11^h\ 33^m\ 0^s$ evening	5° 58′ 0″ ♑	276° 30′ 9″
27	$2^h\ 2^m\ 0^s$ morning	6° 4′ 30″	276° 36′ 40″
	$2^h\ 37^m\ 15^s$ morning	6° 4′ 30″	276° 36′ 40″
	$4^h\ 59^m\ 30^s$ evening	6° 43′ 0″ ♑	277° 5′ 25″
	$5^h\ 5^m\ 0^s$ evening	6° 43′ 0″	277° 5′ 25″
	$5^h\ 11^m\ 0^s$ evening	6° 43′ 0″	277° 5′ 25″
	$6^h\ 47^m\ 30^s$ evening	6° 47′ 0″ ♑	277° 23′ 23″
	$6^h\ 49^m\ 45^s$ evening	6° 48′ 0″	277° 24′ 28″
	$6^h\ 54^m\ 0^s$ evening	6° 48′ 0″	277° 24′ 28″
	$11^h\ 34^m\ 0^s$ evening	7° 0′ 0″ ♑	277° 37′ 30″
	$11^h\ 37^m\ 45^s$ evening	7° 0′ 0″	277° 37′ 30″
28	$1^h\ 34^m\ 0^s$ morning	7° 5′ 0″	277° 42′ 55″
	$1^h\ 57^m\ 0^s$ morning	7° 5′ 0″ ♑	277° 42′ 55″
	$1^h\ 59^m\ 0^s$ morning	7° 5′ 0″	277° 42′ 55″
29	$4^h\ 21^m\ 40^s$ morning	8° 14′ 0″	278° 58′ 2″
	$4^h\ 53^m\ 0^s$ morning	8° 14′ 0″ ♑	278° 58′ 2″
	$4^h\ 58^m\ 15^s$ morning	8° 14′ 0″	278° 58′ 2″
	$5^h\ 13^m\ 15^s$ morning	8° 14′ 0″	278° 58′ 2″
30	$5^h\ 39^m\ 30^s$ evening	9° 48′ 28″ ♑	280° 40′ 30″
	$6^h\ 55^m\ 0^s$ evening	9° 52′ 0″	280° 44′ 0″
	$7^h\ 3^m\ 15^s$ evening	9° 52′ 0″	280° 44′ 0″
	$7^h\ 6^m\ 35^s$ evening	9° 52′ 0″ ♑	280° 44′ 0″
31	$3^h\ 35^m\ 0^s$ morning	10° 14′ 0″	281° 8′ 0″
	$3^h\ 39^m\ 30^s$ morning	10° 14′ 0″	281° 8′ 0″
	$4^h\ 29^m\ 30^s$ morning	10° 16′ 0″ ♑	281° 12′ 0″
	$4^h\ 44^m\ 0^s$ morning	10° 16′ 0″	281° 12′ 0″

[4]ruled into three groups of three lines, like the table beside it.

1652 December, day	By the mechanical clock, uncorrected (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
January 1	$2^h\ 11^m\ 30^s$ morning	11° 14′ 0″ ♑	282° 12′ 0″
In the year	$2^h\ 15^m\ 0^s$ morning	11° 14′ 0″	282° 12′ 0″
1653	$2^h\ 38^m\ 15^s$ morning	11° 14′ 0″	282° 12′ 0″
	$3^h\ 29^m\ 0^s$ morning	11° 15′ 0″ ♑	282° 15′ 0″
	$3^h\ 32^m\ 10^s$ morning	11° 15′ 0″	282° 15′ 0″
	$3^h\ 56^m\ 40^s$ morning	11° 16′ 0″	282° 17′ 0″
2	$5^h\ 45^m\ 15^s$ evening	12° 54′ 0″ ♑	284° 0′ 40″
	$5^h\ 47^m\ 0^s$ evening	12° 54′ 0″	284° 0′ 40″
	$7^h\ 4^m\ 30^s$ evening	12° 57′ 0″	284° 3′ 53″
	$7^h\ 7^m\ 0^s$ evening	12° 57′ 0″ ♑	284° 3′ 53″
3	$6^h\ 16^m\ 0^s$ evening	13° 54′ 0″	284° 55′ 30″
	$6^h\ 39^m\ 0^s$ evening	13° 54′ 0″	284° 55′ 30″
	$6^h\ 50^m\ 30^s$ evening	13° 58′ 0″ ♑	285° 9′ 46″
	$7^h\ 18^m\ 0^s$ evening	13° 58′ 0″	285° 9′ 46″
	$7^h\ 59^m\ 0^s$ evening	14° 0′ 0″	285° 12′ 40″
	$11^h\ 4^m\ 15^s$ evening	14° 8′ 0″ ♑	285° 20′ 36″
	$11^h\ 9^m\ 0^s$ evening	14° 8′ 0″	285° 20′ 36″
4	$1^h\ 57^m\ 0^s$ morning	14° 15′ 0″	285° 29′ 0″

5

Table showing the true place and right ascension of the Sun, computed from the Rudolphine Tables [recte: ex, "from" — the page prints &, "and", where the same title on the preceding page prints *ex*].

1652 December, day	By the clock, corrected from the altitudes of the stars (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
26	$11^h\ 20^m\ 0^s$ evening	5° 58′ 7″ ♑	276° 30′ 18″
	$11^h\ 38^m\ 22^s$ evening	5° 58′ 55″	276° 31′ 9″
	$11^h\ 44^m\ 48^s$ evening	5° 59′ 10″	276° 31′ 26″
	$11^h\ 50^m\ 31^s$ evening	5° 59′ 27″ ♑	276° 31′ 44″
27	$12^h\ 48^m\ 15^s$ morning	6° 1′ 53″	276° 34′ 23″
	$12^h\ 55^m\ 15^s$ morning	6° 2′ 11″	276° 34′ 42″
	$1^h\ 8^m\ 15^s$ morning	6° 2′ 48″ ♑	276° 35′ 22″
	$1^h\ 24^m\ 45^s$ morning	6° 3′ 25″	276° 36′ 1″
	$2^h\ 6^m\ 0^s$ morning	6° 5′ 12″	276° 37′ 43″
	$5^h\ 14^m\ 5^s$ evening	6° 43′ 51″ ♑	277° 19′ 58″
	$5^h\ 19^m\ 1^s$ evening	6° 44′ 4″	277° 20′ 12″
	$5^h\ 23^m\ 58^s$ evening	6° 44′ 15″	277° 20′ 23″
	$5^h\ 33^m\ 39^s$ evening	6° 44′ 41″ ♑	277° 20′ 52″
	$5^h\ 40^m\ 48^s$ evening	6° 45′ 0″	277° 21′ 12″

[5] this table continues the first Sun table of the preceding page, under a shortened title and a repeated header. The figure lines are ruled into groups of three (one group of two, after the line for 31 December $3^h\ 39^m\ 30^s$). The day numbers, the words "In the year 1653" and the sign ♑ stand only where shown.

1652 December, day	By the clock, corrected from the altitudes of the stars (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
	$5^h\ 50^m\ 9^s$ evening	6° 45′ 24″	277° 21′ 39″
	$6^h\ 20^m\ 21^s$ evening	6° 46′ 41″ ♑	277° 23′ 2″
	$11^h\ 44^m\ 31^s$ evening	7° 0′ 27″	277° 37′ 59″
	$11^h\ 52^m\ 31^s$ evening	7° 0′ 49″	277° 38′ 23″
28	$12^h\ 13^m\ 46^s$ morning	7° 1′ 43″ ♑	277° 39′ 22″
	$1^h\ 34^m\ 10^s$ morning	7° 5′ 10″	277° 43′ 6″
29	$3^h\ 50^m\ 52^s$ morning	8° 12′ 18″	278° 56′ 10″
	$3^h\ 55^m\ 52^s$ morning	8° 12′ 33″ ♑	278° 56′ 26″
	$4^h\ 28^m\ 50^s$ morning	8° 13′ 55″	278° 57′ 55″
	$4^h\ 47^m\ 49^s$ morning	8° 14′ 44″	278° 58′ 48″
	$4^h\ 55^m\ 32^s$ morning	8° 15′ 3″ ♑	278° 59′ 9″
30	$6^h\ 10^m\ 30^s$ evening	9° 50′ 12″	280° 42′ 23″
31	$3^h\ 37^m\ 26^s$ morning	10° 14′ 9″	281° 8′ 20″
	$3^h\ 44^m\ 24^s$ morning	10° 14′ 27″ ♑	281° 8′ 39″
In the year	$4^h\ 15^m\ 16^s$ morning	10° 15′ 48″	281° 10′ 7″
1653	$4^h\ 27^m\ 22^s$ morning	10° 16′ 18″	281° 10′ 40″
January 1	$2^h\ 15^m\ 40^s$ morning	11° 12′ 14″ ♑	282° 11′ 15″
	$2^h\ 20^m\ 43^s$ morning	11° 12′ 25″	282° 11′ 27″
	$2^h\ 24^m\ 55^s$ morning	11° 12′ 35″	282° 11′ 38″
	$2^h\ 52^m\ 49^s$ morning	11° 13′ 46″ ♑	282° 12′ 55″
	$3^h\ 3^m\ 48^s$ morning	11° 14′ 14″	282° 13′ 25″
	$3^h\ 26^m\ 0^s$ morning	11° 15′ 12″	282° 15′ 8″
	$3^h\ 44^m\ 0^s$ morning	11° 15′ 58″ ♑	282° 15′ 58″
2	$6^h\ 27^m\ 30^s$ evening	12° 54′ 53″	284° 2′ 18″
3	$6^h\ 47^m\ 30^s$ evening	13° 57′ 1″	285° 9′ 27″
4	$2^h\ 3^m\ 24^s$ morning	14° 15′ 35″ ♑	285° 29′ 28″
	$2^h\ 39^m\ 10^s$ morning	14° 17′ 6″	285° 31′ 5″
	$2^h\ 59^m\ 30^s$ morning	14° 17′ 58″ ♑	285° 32′ 2″
7	$2^h\ 26^m\ 9^s$ morning	17° 20′ 24″ ♑	288° 48′ 2″
	$2^h\ 41^m\ 0^s$ morning	17° 21′ 3″	288° 48′ 44″

6

True longitudes and right ascensions of the Sun, for working out the true time from the altitudes of the fixed stars.

1653 January, day	By the mechanical clock, uncorrected (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
4	$2^h\ 19^m\ 0^s$ morning	14° 15′ 0″ ♑	285° 29′ 9″
	$2^h\ 35^m\ 30^s$ morning	14° 16′ 0″	285° 29′ 13″
	$3^h\ 1^m\ 30^s$ morning	14° 18′ 0″	285° 31′ 17″

[6] this table continues the second Sun table of the preceding page. The figure lines are ruled into groups of three, the last group (7 January) of two. The day numbers, the words "In the year 1653" and the sign ♑ stand only where shown; in this table "In the year 1653" stands in the last two lines of the 31 December group, above "January 1", where the table beside it sets "January 1" first.

1653 January, day	By the mechanical clock, uncorrected (h m s)	True place of the Sun (° ′ ″, sign)	Right ascension of the Sun (° ′ ″)
	$3^h\ 7^m\ 0^s$ morning	14° 18′ 0″ ♑	285° 31′ 17″
7	$1^h\ 31^m\ 0^s$ morning	17° 18′ 0″	288° 45′ 28″
	$1^h\ 33^m\ 0^s$ morning	17° 18′ 0″	288° 45′ 28″
	$2^h\ 26^m\ 15^s$ morning	17° 20′ 0″ ♑	288° 47′ 36″
	$2^h\ 40^m\ 45^s$ morning	17° 22′ 0″	288° 49′ 45″
	$3^h\ 2^m\ 0^s$ morning	17° 23′ 30″	288° 50′ 50″
	$3^h\ 25^m\ 15^s$ morning	17° 24′ 0″ ♑	288° 51′ 54″
	$3^h\ 45^m\ 40^s$ morning	17° 24′ 0″	288° 51′ 54″

7

[Margin: Investigation of the true time from the altitudes and azimuths of the fixed stars.]

Now let us turn to the task itself and, from all the observed altitudes and azimuths of the fixed stars, work out the true time, so that afterwards, from that corrected time, every time estimated by the clocks [automata] can be corrected. To make everything the clearer to everyone, and at the same time to hold a torch up for beginners and show the way that I have followed, and that they in turn must tread in similar cases, in this first example of ours let us set out the calculation itself in its full sequence, preceded by a visual demonstration, and supply rules for how everything is derived by spherical triangles, and indeed, with the help of logarithms, by a short route. Since, however, on 20 December, when the comet first shone on us, nothing at all certain was observed with the large instruments, let us begin from 23 December.

[Margin: Example of the calculation.]

Let it be sought, then: in the year 1652, on the 23rd of the current month of December, in the evening, at $5^h\ 37^m\ 50^s$ by the mechanical clock — the estimated time, that is — what the true time was, from the first observed altitude of the Palilicium, 27° 31′ 0″. This is done from the given true place of the Sun at the same estimated time and its right ascension, together with the declination of the star and the elevation of the pole at Danzig, in the following way.

Diagram. An engraved circle representing the sphere, set to the right of the text. The outer circle is the solstitial colure or meridian, with C at upper left, F at the top, E at upper right, B at right, D at lower right and A at left. A straight line from A to B is labelled *Horizon.*; a line from C to D is labelled *Æquator.* [?] (the first letter of this inscription is engraved as either Æ or A). From E an arc runs down-left through the star G (drawn as an asterisk) to I on the line CD; its upper part, E to G, is labelled *Compl. Declin.* (complement of the declination) and its lower part, G to I, *Declinatio.* (declination). The stretch from C to I along CD is labelled *Diſt. à Mer.* (distance from the meridian). A

[7]the table is headed "In the year 1653, January, day". The figure lines are ruled into groups of three, the last group of two. The day number 7 stands level with the middle line of the second group, as set here; the sign ♑ stands only where shown. The first line marks the morning as *man.*, the rest as *m.*

line from F through G down to H on the horizon is labelled *Altitudo.* (altitude) along G–H. The arc from E down to B is labelled *Elevatio Poli.* (elevation of the pole). Along the horizon near A stands *Azimuth.* A dotted line runs from G up to K on the circle; dotted lines run from F up to L, outside the circle, and from L down to E. In the lower right corner: *Autor Sculps.* ("the author engraved it").

- A (left, on the circle): end of the horizon
- B (right, on the circle): end of the horizon
- C (upper left, on the circle): end of the equator
- D (lower right, on the circle): end of the equator
- E (upper right, on the circle): pole of the equator
- F (top, on the circle): vertical point, pole of the horizon
- G (interior, asterisk): the star
- H (on the horizon): foot of the vertical circle through G
- I (on the equator): foot of the declination circle through G
- K (upper left, on the circle): end of the dotted line from G
- L (outside the circle, top right): apex of the dotted lines from F and E[8]

1. In the accompanying diagram let the circle ACFEBD be the solstitial colure, or meridian; AB the horizon, whose pole, or vertical point, is F; CD the equator, whose pole is E. The quadrant of the circle of declination EI, drawn from E through the star G, shows GI, the declination of the star, and IC, its distance from the meridian; the vertical circle, descending through the star G, shows HG, the altitude of the star, and HA, its azimuth.

[Margin: Method of the calculation.]

The whole calculation depends on solving the oblique-angled triangle GFE, so that from all the given sides the angle at E is found, which is measured by the arc CI, namely the distance of the star from the meridian. Therefore, since all the sides are known — FE, namely the complement of the elevation of the pole at Danzig, 35° 37′; GE, the complement of the declination, namely that of the Palilicium, 74° 13′; and HG, the observed altitude of the said Palilicium, 27° 31′ East — you will carry out the calculation itself by logarithms in this way: of the two sides en- closing the sought angle, let the difference be added to the third side and taken from it. From the sum of the logarithms of the half-sum and the half-remainder, subtract the sum of the logarithms belonging to the two sides named above (those enclosing the sought angle): half the remainder is the logarithm of half the sought angle. But to put it more clearly:

1. Let the logarithm of the elevation of the equator, that is, of the complement of the elevation of the pole, EF, be added to the logarithm of the complement of the declination, GE; or, what comes to the same thing, let the antilogarithm of the elevation of the pole be added to the antilogarithm of the declination, GI.

[8] every letter and inscription listed was read on the plate; none is left unread. K and L are not named in the text on this page.

2. Let the difference between the elevation of the equator and the complement of the declination be added to the complement of the altitude and subtracted from it, and let both the sum and the remainder be halved.
3. Let the logarithms of the halves be added; from this sum let the sum of the antilogarithms of the first step be subtracted. Half the remainder is the logarithm of half the distance from the meridian that is sought.
4. Let the whole distance from the meridian so found be added to the right ascension of the star if the altitude was western, but subtracted from the right ascension of the star if it was eastern. The sum or remainder is then the right ascension of the midheaven, that is, of the culminating point. When the right ascension of the Sun is subtracted from this, as it always is, there remains the elongation of the Sun from the meridian, to be converted into time counted from the past noon. For example:

Line	Arc	Degrees	Logarithm	Note
Elevation of the pole at Danzig	EF	54° 23′	Antilog. 54067	
Declination of the Palilicium	GI	15° 47′	Antilog. 3843	*A.*
First sum			57910	
Elevation of the equator		35° 37′		
Complement of the declination ⋆	GE	74° 13′		
Difference		38° 36′		
Complement of the altitude of the star		62° 29′		
Sum		101° 5′		
Half		50° 32½′	25866	Logarithm
		--		
Difference		23° 53′		
Half		11° 56½′	157545	Logarithm
Second sum			183411	
First sum			57910	
Remainder			125501	
Half is the logarithm of the half-distance		32° 16′ 15″62750		
Therefore the whole distance of the Palilicium from the meridian		64° 32′ 30″		
Right ascension of the Palilicium		64° 2′ 0″		
		360° 0′ 0″		
Add the whole circle to the right ascension of ⋆, as usual		424° 2′ 0″		
From this, with the distance from the meridian subtracted, there remains		359° 29′ 30″		*Asc. R. M. C.* (right ascension of the midheaven)
Right ascension of the Sun, subtracted		272° 54′ 12″		
The remainder is the elongation of the Sun from the meridian		86° 35′ 18″		
The hours from the preceding noon corresponding to it		$5^h\ 46^m\ 21^s$		The time
namely the one sought; it therefore differs from the estimated time by		$7^m\ 31^s$		

9

[Margin: Another way of computing the true time.]

In this way the true time was computed from all the altitudes of the fixed stars. Sometimes, too, for greater certainty, we also sought that true time by an entirely different method, namely from the given azimuth and altitude of the star. So here too it is convenient to set out the method of demonstration and of computation, for the benefit of beginners.

In the preceding diagram on p. 21, let a perpendicular GK be dropped to the meridian. This must first be found in the triangle GFK, namely from the side GF, the complement of the altitude of the star, and the angle GFK, which is measured by the azimuth AH, observed [recte: obſervatum; printed abſervatum] as 78° 26′: the sum of the logarithms of the two givens is the logarithm of the perpendicular KG that is sought. Then, in the other triangle KGE, with the perpendicular KG and GE, the complement of the declination, known, the angle GEK is found, which measures the sought distance of the star from the meridian, CI. That is, the logarithm of GE, the complement of the declination, subtracted from the logarithm of the perpendicular KG just found, leaves the logarithm of the sought angle E, or of the distance of the star from the meridian, CI; by means of this the true time will come out in the usual way.

[Margin: Example of the calculation.]

For example:

Line	De-grees	Loga-rithm	Angle and arcs
Logarithm of the azimuth	78° 26′	2052	
Log. of the complement of the altitude of the Palilicium	62° 29′	12005	
The sum is the log. of the perpendicular KG		14057	
Log. of the complement of the declination of the star, subtracted		3843	
There remains the log. of the distance of the star from the meridian		10214	whose angle is 64° 32′ 35″
Right ascension of the Palilicium, with 360° added			424° 2′ 0″
Remainder, and right ascension of the midheaven			359° 29′ 25″
Right ascension of the Sun from the table, which is always subtracted			272° 54′ 0″
And so the elongation of the Sun from the meridian			86° 35′ 25″

[9]the page sets this calculation as unruled lines, italic labels with roman figures, with short rules under the figures of the second, fifth, seventh, eleventh, thirteenth, eighteenth and twenty-first lines. The columns above follow the page's alignment; the logarithm 62750 stands to the left of 32° 16′ 15″ on the page. The asterisk is the page's own sign; on p. 65 the star G is drawn as an asterisk. The tag *A.* after 3843 is not expanded on the page. The words "The time, namely the one sought" run from the end of the second-last line into the last. The printed difference $7^m\ 31^s$ does not equal the difference between $5^h\ 46^m\ 21^s$ and the estimated clock time of p. 65, $5^h\ 37^m\ 50^s$, which is $8^m\ 31^s$; the figure is given as printed.

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Converted into time, these give $5^h\ 46^m\ 21\frac{1}{2}^s$, the true time, and indeed, as before, right down to the seconds. This method of finding the true time through the azimuth and the altitude is certainly far quicker than through the altitude alone, provided that the azimuth has been obtained with due care — though recording it correctly takes skill and labour, as those experienced in these matters know best.

[Margin: How the time is to be derived from azimuths.]

Sometimes, too, for greater certainty, we derive the true time from the azimuth alone, by a calculation that is admittedly somewhat longer, but very necessary to know in observations of this kind. It is done in this way. In the obtuse-angled triangle GEF of the figure above, the angle at E is likewise to be found, from the givens FE, the complement of the elevation of the pole, and EG, the complement of the declination of the star, and from the angle F, namely the azimuth. Before we come to that, however, it is necessary first to find, in the smaller triangle FLE drawn with dotted lines, the side LE, from EF, the complement of the elevation of the pole, and the angle EFL, which equals the azimuth, as being its vertical angle AFH. That is: the sum of the logarithms of the two givens is the logarithm of the sought side LE.

2. Let the side FL be found from the two given sides LE and FE. That is: the antilogarithm of the side LE, subtracted from the antilogarithm of the hypotenuse FE, leaves the antilogarithm of the sought side FL.
3. In the same triangle the angle FEL is also to be sought, from the hypotenuse and the side opposite the sought angle. That is: the logarithm of the hypotenuse FE, subtracted from the logarithm of the side FL, leaves the logarithm of the sought angle FEL.[11]
4. And finally, in the larger right-angled triangle GLE, let the angle GEL be found from the givens, namely GE, the complement of the declination of the star, and the side LE, found in the first step. That is: the mesologarithm [Meſologarithmus] of the hypotenuse GE, subtracted (cossically [cosſicè], if need be) from the mesologarithm of the side LE, leaves the antilogarithm of the sought angle GEL. From this angle, once found, let the smaller angle FEL, found in the third step, be taken away, and there will remain the angle GEF, or IEC, the sought distance of the star from the meridian. From it, as before, the elongation of the Sun from the meridian is obtained,

[10] the page sets this calculation as unruled lines, italic labels with roman figures, with short rules under the figures of the second, fourth, sixth and eighth lines. The columns above follow the page's alignment: the words "whose angle" and the figures 64° 32′ 35″ stand on the same line as the logarithm 10214, to its right. Where p. 66 has 64° 32′ 30″, 359° 29′ 30″ and 272° 54′ 12″, this page prints 64° 32′ 35″, 359° 29′ 25″ and 272° 54′ 0″; all are given as printed.

[11] the first step of this second method carries no printed number; the numbering on the page begins at 2.

and consequently the true time itself; we shall illustrate this with the same example of ours.

[Margin: Example of the calculation.]

Step	Line	Degrees	Logarithm	Mark	Result
1.	Complement of the elevation of the pole, FE	35° 37′	Log. 54067		
	Azimuth, CI or FLE	78° 26′	Log. 2052	*A.*	
	The sum is the logarithm of the side EL		56119		34° 47′ 14″ EL
2.	Antilogarithm of the side EL		19689	*S.*	
	Antilog. of the hypotenuse FE		20711		
	The remainder is the side FL, antilog.		1022		8° 10′ 55″ FL
3.	Log. of the hypotenuse FE, the complement of the elevation of the pole		54067	*S.*	
	Logarithm of the side FL		195002		
	leaves the log. of the sought angle FEL		140935		14° 8′ 27″ FEL.
4.	Mesol. of the hypotenuse GE, the complement of the declination of the star		126352	— *S.* cossically, that is, add	
	Mesologarithm of the side LE		36430	+	
	leaves the antilog. of the angle GEL		162782	+	78° 40′ 34″
	from which let the angle FEL be subtracted				14° 8′ 27″
	And you will have the sought angle GEF, or IC, the distance from the meridian				64° 32′ 7″
	The right ascension of the Palilicium, with 360° added, is found to be				424° 2′ 0″
	The remainder is the right ascension of the midheaven				359° 29′ 53″
	Right ascension of the Sun, to be subtracted				272° 54′ 0″
	Therefore the elongation of the Sun from the meridian				86° 35′ 53″

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Converted into time, this shows $5^{h}\ 46^{m}\ 23\frac{1}{2}^{s}$, the true time sought, exactly as above except for two seconds. You see, therefore, friendly reader, how precisely these methods agree with one another, even though they are entirely different. And although in these observations it has usually not been tedious for me to seek the true time even by all three of these routes together, I do not wish to bring all these calculations before the public; to keep the work from growing

[12] the page sets this calculation as unruled lines, italic labels with roman figures, with short rules under the figures of the second, fifth, eighth, eleventh, fourteenth and seventeenth lines. The columns above follow the page's alignment. The second line names the azimuth "C I vel F L E" as printed. The tags *A.* and *S.* are not expanded on the page; the dash after 126352 and the plus signs after 36430 and 162782 are the page's own marks. The figures of the last six lines are printed without degree, minute and second marks.

to an immense size, it will be enough merely to have shown by what method the true time, which has been entered alongside the preceding observations, was computed. Anyone who wishes, and has the leisure, can recompute one or two examples, if not all of them; I have no doubt whatever that they will find everything was handled by us with the utmost care and good faith.

Section IV. Given the Comet's Altitude, the True Time and the Azimuth, to Find Its Declination and Right Ascension [SECTIO IV. Datis Cometæ altitudine, vero tempore, & Azimutho, inveſtigare ejus Declinationem, & Aſcenſionem Rectam.]

Since the comet was not always observed in the same place in the sky, but now in this region and now in that, the calculation itself must also be demonstrated from different figures, each showing one of the quadrants of the sky. We have therefore thought it worthwhile to set out four such diagrams here, by which every case can be resolved with the greatest ease. Before we present the calculation itself, with its whole analysis, for our first observation, let us first set out the method of that calculation, which is beyond doubt, together with the necessary rules. After that we shall present the remaining examples as briefly as possible, yet in such a way that the principal members of the calculation are still open to everyone, and every suspicion that some error has been committed is forestalled.

I am not afraid of the light, nor of setting everything out clearly, since I am quite certain (vain glory aside) that everything has been worked out with the greatest accuracy — not only as regards the declinations and right ascensions, but all the subsequent results as well. I can affirm this the more safely because, without any outside help whatever, I myself alone set up and checked the calculations of everything presented in this work, not once only but twice.

[Margin: Autor ſolus omnia ſupputavit ac debitè examinavit.] [The author alone computed everything and duly checked it.]

I admit, however, that among the remaining examples some will be found that will seem to some readers partly unsteady. These are certainly to be attributed not to carelessness but solely to the observed azimuths, which run out to about 90°. For I would have you note well that when the azimuth already exceeds 75°, the obtuse angle of the triangle to be solved is too large for the declination and right ascension — and consequently the longitude and latitude as well — to be obtained accurately enough in any way, however diligently the observation was made and however properly the calculation was derived from it. Hence in the business of parallaxes we also attribute less weight to those observations than to the rest. Nevertheless we have gladly set these out worked through as well, so as not to seem to have omitted some on purpose and brought forward only selected ones. But to the matter itself.

[Margin: Quare nonnullæ ſupputationes ex parte vacillare videantur?] [Why do some computations seem partly unsteady?]

In the four figures that follow, the circles and their names correspond entirely to the diagram inserted in Section III, p. 21, so there is no need for me to name them again. Only this needs to be stated: the first figure shows the face of the sky with the comet placed in the eastern, more southerly quadrant; the second in the eastern, more northerly; the third in the western, more southerly; and the fourth in the western, more northerly quadrant. Likewise, in each the perpendicular GK has been drawn from the comet's apparent place to the meridian. For the demonstration of our first example the first of the following figures will serve us, since the azimuth, as is plain, was observed at 48° 19′ towards the east.

[Margin: Analyſis calculi pro declinatione & Aſc. Recta.] [Analysis of the calculation for the declination and right ascension.]

1. In this figure, then, in its triangle GFK, right-angled at K, we are given GF, the complement of the altitude, and the angle GFK, which is measured by the azimuth AH. First let the perpendicular GK be sought, by this rule: the sum of the logarithms of the two givens is the logarithm of the perpendicular sought.

Diagram. The first of four engraved circle diagrams set two by two across the middle of the page. A circle crossed by the horizon from B to A, the equator running from D up towards C, and great circles through F; the comet G is drawn as a star, with a dotted arc from G to K. The numeral 1 is engraved below the centre.

- Capital letters: F (top), E (upper left), K (upper right), C (right), G (at the star), I (below right of G), B (left), H (on the horizon), A (right), D (lower left)
- Compl. Declin. (complement of the declination), on the arc from E to G
- Compl. Alt. (complement of the altitude), on the arc from F to G
- Declin. (declination), on the arc from G to I
- Elevatio Poli. (elevation of the pole), along the circle at upper left
- Diſt. à M. (distance from the meridian), on the arc from I to C
- Horizon., Altitudo. (altitude, on the arc from G to H), Azimuth., Æquator. (equator)
- 1 (the diagram's number)

Diagram. The second diagram, upper right, numbered 2: the same construction mirrored, with A at the left and B at the right.

- Capital letters: F (top), K (upper left), E (upper right), C (left), G (at the star), I (lower left of G), A (left), H (on the horizon), B (right), D (lower right)
- Compl. Decl., on the arc from G towards E
- Comp[?] Alt., on the arc from G to F; the engraved word may or may not carry an l after Comp
- Declin., on the arc from G to I
- Diſt. à M[?], on the arc from C to I; the end of the inscription is not read beyond the M

- Elevatio Poli., along the circle at right
- Azimuth., Altitudo, Horizon., Æquator.
- 2 (the diagram's number)

Diagram. The third diagram, lower left, numbered 3, with B at the left and A at the right.

- Capital letters: F and K (top), E (upper right), D (upper left), G (at the star), I (left, near the horizon), B (left), H (on the horizon), A (right), C (lower right)
- Declinat., on the arc from G towards D
- Diſt. à Mer. (distance from the meridian), on the arc from D to I
- Comp Decl., on the arc from G to E
- Elevatio Poli., along the circle at right
- Horizon., Altitudo, Azimuth, Æquator.
- 3 (the diagram's number)

Diagram. The fourth diagram, lower right, numbered 4, with B at the left and A at the right.

- Capital letters: F (top), E (upper right of F), D (upper left), K (right), G (at the star), A (right), H (on the horizon), I (below the horizon), B (left), C (lower right)
- Compl. Altitud., on the arc from F to G
- Comp. Dec., on the arc from E to G
- Altitud., on the arc from G to H
- Declinatio., on the arc from G to I
- Diſt. à M. S., on the arc from I to C
- Azimuth, Horizon., Æquator.
- 4 (the diagram's number)

Between the two lower diagrams is engraved: *Autor Sculpſit.* [The author engraved it.]

2. In the same triangle, from the two sides GF, the complement of the altitude, and KG, the side just found, let the side KF be sought, as follows: the antilogarithm of the side, subtracted from the antilogarithm of the hypotenuse, leaves the antilogarithm of the side sought.
3. Let this side KF, once found, be added to the side FE, the complement of the elevation of the pole, or the elevation of the equator, 35° 37′ 8″, to give KE — that is, in the first and second quadrants. In the third and fourth, however, they are subtracted from each other, the smaller side from the larger; the reason is evident from the figures.
4. In the right-angled triangle GKE, from the two sides KE and GK, let the hypotenuse GE, that is, the complement of the declination, be sought in this way: the sum of the antilogarithms of the two sides is the antilogarithm of the hypotenuse. Then let this last result, namely the hypotenuse, be subtracted from a quadrant, and the declination itself will remain.
5. In the same triangle GKE, from the two given sides — GE, the hypotenuse, that is, the complement of the altitude of the comet, and GK, found first

— let the angle GEK be found, which measures the distance from the meridian CI, name- ly: the logarithm of the hypotenuse, subtracted from the logarithm of the side, leaves the logarithm of the angle sought.

6. Let the true time be converted into degrees, to give the elongation from the meridian. To this the right ascension of the Sun is always added, and so the right ascension of the midheaven will result. If this is greater than a full circle, its excess — or, if it is less, its complement to 360° — is added to the distance from the meridian in the eastern quadrant; in the western quadrant, however, the latter is subtracted from the former. You will thus have the right ascension of the phenomenon sought; if it is greater than a full circle, let the whole circle be thrown off from it. Note, however, that if the azimuth exceeds a quadrant, so that it grows beyond 90° and inclines towards the north, you must use the supplement to a semicircle of the distance from the meridian, not the simple distance from the meridian. But an example will make the matter clearer.

Let there be sought, then, for the year 1652, December 23, at 7^h 22^m 7^s in the evening — the corrected time — the comet's declination and right ascension, from its observed altitude of 44° 28′ in the east and azimuth of 48° 19′ [Quæratur itaq; ad Annum 1652. d. 23. Decembris, Hor. veſp. 7 22′ 7″ tempus ſcilicet correctum, Cometæ Declinatio & Aſcenſio Recta, ex altitudine ejus 44° 28′ Orient. & Azimutho 48° 19′ Obſervat.]

Observation 1 [Obſervatio 1.]

Line	Arc	Loga- rithm	Mark	Value	Remark
Logarithm of the azimuth		29191			
Logarithm of the complement of the altitude		33735	*always to be added*		
Logarithm of the perpendicular	KG	62926		32° 12′ 26″	
Antilogarithm of the complement of the altitude		35597			
Antilogarithm of the perpendicular	KG	16709	*Subt.*		
Antilogarithm	KF	18888		34° 7′ 3″	
Elevation of the equator, or	FE			35° 37′ 8″	
Side	KE			69° 44′ 11″	
Antilogarithm	KE	106033			
Antilogarithm of the perpendicular	GK	16709	*A.*		
Antilog. of the complement of the declination		122742	GE	72° 57′ 34″	
				89° 59′ 60″	*Quadrant of the circle*
is the declination itself sought	GI			17° 2′ 26″	*North*
Logarithm of the perpendicular	KG	62927			
Logarithm of the hypotenuse	GE	4490	*S.*		*or of the complement of the declination*
Logarithm of the angle	GEK	58437	or IC	33° 52′ 50″	*distance from the meridian*
7^h				105° 0′ 0″	

Line	Arc	Logarithm	Mark	Value	Remark
22^m				5° 30′ 0″	
7^s				1′ 45″	
Elongation from the meridian				110° 31′ 45″	
Right ascension of the Sun, *add*				272° 58′ 55″	
Right ascension of the midheaven				383° 30′ 40″	
Full circle				360°	
Excess over the full circle				23° 30′ 40″	
Distance from the meridian				33° 52′ 50″	*add, in the eastern quadrant*
Right ascension of the comet				57° 23′ 30″	*sought*

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Observation 2 [Obſervatio 2.]

From the comet's altitude of 50° 43′ 15″ in the west and azimuth of 31° 20′, observed at the true time of December 23, 10^h 57^m 20^s, let the comet's declination and right ascension be sought.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		65389			
Log. of the compl. of the altitude		45712	*A.*		
Log. of the perpendicular	KG	111101		19° 13′ 19″	
Antilog. of the compl. of the altitude		25609			
Antilog. of the perpendicular	KG	5730	*S.*		
Antilog.	KF	19879		34° 56′ 40″	*A*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			70° 33′ 48″	
Antilog.	KE	110033			
Antilog. of the perpendicular	GK	5730	*A*		
Antilog. of the compl. of the declination		115763		71° 41′ 9″	*whose complement to 90°*
is the declination itself sought				18° 18′ 51″	*North*
Log. of the perpendicular	KG	111101			
Log. of the hypotenuse	GE	5198	*S.*		
Log. of the angle sought		105903	GEK	20° 17′ 30″	*distance from the meridian*

[13] the page sets this calculation as unruled lines, italic labels with roman figures, with short rules under the figures of the second, fifth, seventh, tenth, twelfth, fifteenth, nineteenth, twenty-first, twenty-third and twenty-fifth lines. The columns above follow the page's alignment. Only the values of the third, eleventh and sixteenth lines and the 105° of the seventeenth are printed with degree, minute and second marks; the rest stand as bare figures in the degree, minute and second positions. The hour, minute and second rows are printed "Hor. 7", "22′" and "7″". The 1 45 of the nineteenth line stands in the minute and second positions with nothing in the degree position. The tags *A.* and *S.* are not expanded on the page. The logarithm of the perpendicular KG is printed 62926 in the third line and 62927 in the fourteenth. The fourth line prints "alitud." for "altitud."

Line	Arc	Logarithm	Mark	Value	Remark
Elongation from the meridian				164° 20′ 0″	
Right ascension of the Sun				273° 8′ 57″	*A*
The sum, 360° thrown off, is the right ascension of the midheaven				77° 28′ 57″	*from which*
subtract the distance from the meridian, and it gives the right ascension				57° 11′ 27″	*of the comet*

Observation 3 [Obſervatio 3.]

From the comet's altitude of 48° 4′ 45″ in the west and azimuth of 42° 14′, observed at the true time of December 23, 11^h 28^m, let the comet's declination and right ascension be sought.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		39727			
Log. of the compl. of the altitude		40332	*A.*		
Log. of the perpendicular	KG	80059		26° 41′ 1″	
Antilog. of the compl. of the altitude		29562			
Antilog. of the perpendicular	KG	11261	*S*		
Antilog.	KF	18301		33° 37′ 0″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			69° 14′ 8″	
Antilog.	KE	103697			
Antilog. of the perpendicular	GK	11261	*A.*		
Antilog. of the compl. of the declination		114958		71° 31′ 57″	*whose complement to 90°*
is the declination itself sought				18° 28′ 3″	*North*
Log. of the perpendicular	KG	80059			
Log. of the hypotenuse	GE	5286	*S.*		
Log. of the angle GEK		74773	or IC	28° 15′ 28″	*distance from the meridian*
Elongation from the meridian				172° 0′ 0″	
Right ascension of the Sun				273° 10′ 21″	
The sum, 360° cast off, right ascension of the midheaven				85° 10′ 21″	*from which*
subtract the distance from the meridian: right ascension of the comet				56° 54′ 53″	*sought*

Observation 4 [Obſervatio 4.]

From the comet's altitude of 33° 36′ in the west and azimuth of 75° 9′, observed in the morning at the true time of December 24, 1^h 27^m 30^s, let the comet's declination and right ascension be sought.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		3389			

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the compl. of the altitude		18282	*A.*		
Log. of the perpendicular	KG	21671		53° 37′ 30″	
Antilog. of the compl. of the altitude		59169			
Antilog. of the *prop.*	KG	52246	*S.*		
Antilog.	KF	6923		21° 4′ 27″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			56° 41′ 35″	
Antilog.	KE	59941			
Antilog. of the *prop.*	GK	52246	*A.*		
Antilog. of the compl. of the declination		112187		70° 59′ 32″	*complement to 90°*
is the declination itself				19° 0′ 28″	*North*
Log. of the perpendicular	KG	21671			
Log. of the hypotenuse	GE	5607	*S.*		
Log. of the angle	GEK	16064	or IC	58° 23′ 10″	*distance from the meridian*
Elongation from the meridian				201° 52′ 30″	
Right ascension of the Sun				273° 15′ 54″	
The sum, 360° thrown off, is the right ascension of the midheaven				115° 8′ 24″	*from which*
subtract the distance from the meridian: right ascension of the comet				56° 45′ 14″	*sought*

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Observation 5 [Obfervatio 5.]

From the comet's altitude of 30° 53′ in the west and azimuth of 79° 55′, observed in the morning at the true time of December 24, $1^h\ 44^m\ 15^s$.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		1557			
Log. of the compl. of the altitude		15290	*A*		
Log. of the perpendicular	KG	16847		57° 40′ 3″	
Antilog. of the compl. of the altitude		66691			
Antilog. of the *prop.*	KG	62580	*S.*		
Antilog.	KF	4111		16° 19′ 0″	*A*
Elevation of the equator, or the arc	FE			35° 37′ 8″	
	KE			51° 56′ 8″	
Antilog.	KE	48362			
Antilog. of the perpendicular	GK	62580	*A.*		
Antilog. of the compl. of the declination		110942		70° 44′ 47″	*whose complement to 90°*
is the declination itself sought				19° 15′ 13″	*North*
Log. of the perpendicular	KG	16847			

[14] the first three lines of this calculation stand at the foot of the left column, which closes with the column catchword "Antil."; the rest heads the right column. Its fifth and tenth lines print "prop" where the other calculations print "perp".

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the hypotenuse	GE	5756	*S.*		
Log. of the angle	GEK	11091	or IC	63° 30′ 45″	*distance from the meridian*
Elongation from the meridian				206° 3′ 45″	
Right ascension of the Sun				273° 16′ 42″	
The sum, 360° thrown off, is the right ascension of the midheaven				119° 20′ 27″	*from which*
subtract the distance from the meridian: right ascension of the comet				55° 49′ 42″	*sought*

Observation 6 [Obſervatio 6.]

From the comet's altitude of 52° 36′ 30″ in the west and azimuth of 71° 22′, observed in the evening at the true time of December 26, 11^{h} 38^{m} 22^{s}.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		5384			
Log. of the compl. of the altitude		49881	*A.*		
Log. of the perpendicular	KG	55265		35° 7′ 44″	
Antilog. of the compl. of the altitude		23005			
Antilog. of the perpendicular	KG	20104	*S.*		
Antilog.	KF	2901		13° 44′ 4″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			49° 21′ 12″	
Antilog.	KE	42863			
Antilog. of the perpendicular	GK	20104	*A*		
Antilog. of the compl. of the declination		62967		57° 48′ 25″	
is the declination itself sought				32° 11′ 35″	

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Line	Arc	Logarithm	Mark	Value	Remark
Log. of the perpendicular	KG	55265			
Log. of the hypotenuse	GE	16694			
Log. of the angle	GEK	38571	IC	42° 50′ 30″	*distance from the meridian*
Elongation from the meridian				174° 35′ 30″	
Right ascension of the Sun				276° 31′ 9″	*A.*

[15] the page sets its six calculations unruled, in two columns, italic labels with roman letters and figures, with short rules under the figures to be added or subtracted. The columns above follow the page's alignment. Only the value of each calculation's third, sixth (Observations 2, 4, 5) and fifteenth lines carries degree, minute and second marks on the page; the rest stand as bare figures in the degree, minute and second positions. The tags *A.* and *S.* and the label *prop.* are not expanded on the page. The calculation for Observation 6 continues overleaf.

Line	Arc	Logarithm	Mark	Value	Remark
The sum, 360° cast off, is the right ascension of the midheaven				91° 6′ 39″	*from which*
subtract the distance from the meridian: right ascension of the comet				48° 16′ 9″	*sought*

16

Observation 7 [Obſervatio 7.]

From the comet's altitude of 51° 36′ 15″ in the west and azimuth of 73° 11′, observed at the true time of December 26, $11^h\ 44^m\ 48^s$.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		4371			
Log. of the compl. of the altitude		47628	*A*		
Log. of the perpendicular	KG	51999		36° 28′ 41″	
Antilog. of the compl. of the altitude		24369			
Antilog. of the perpendicular	KG	21806	*S.*		
Antilog.	KF	2563		12° 55′ 0″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			48° 32′ 8″	
Antilog.	KE	41226			
Antilog. of the perpendicular	GK	21806	*A.*		
Antilog. of the compl. of the declination		63032		57° 49′ 49″	*complement to 90°*
is the declination itself sought				32° 10′ 11″	*North*
Log. of the perpendicular	KG	51999			
Log. of the hypotenuse	GE	16667	*S.*		
Log. of the angle	GEK	35332		44° 37′ 0″	*distance from the meridian*
Elongation from the meridian				176° 12′ 0″	
Right ascension of the Sun				276° 31′ 26″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				92° 43′ 26″	*from which*
subtract the distance from the meridian: right ascension of the comet				48° 6′ 26″	*sought*

17

Observation 8 [Obſervatio 8.]

From the comet's altitude of 50° 44′ in the west and azimuth of 74° 54′, observed in the evening at the true time of December 26, $11^h\ 50^m\ 31^s$.

[16] these seven lines complete the calculation for Observation 6 begun on p. 72. The hypotenuse line carries no tag after its figure.

[17] the statement prints "& Occ. &", with an "&" before "Occ." as well as after it. The thirteenth line prints "Leg." for "Log."

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		3514			
Log. of the compl. of the altitude		45739	*A*		
Log. of the perpendicular	KG	49253		37° 40′ 3″	
Antilog. of the compl. of the altitude		25591			
Antilog. of the perpendicular	KG	23373	*S*		
Antilog.	KF	2218		12° 1′ 28″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			47° 38′ 28″	
Antilog.	KE	39485			
Antilog. of the perpendicular	GK	23373	*A*		
Antilog. of the compl. of the declination		62858		57° 46′ 13″	*complement to 90°*
is the declination itself sought				32° 13′ 47″	*North*
Log. of the perpendicular	KG	49253			
Log. of the hypotenuse	GE	16733	*S.*		
Log. of the angle	GEK	32520		46° 15′ 6″	*distance from the meridian*
Elongation from the meridian				177° 37′ 45″	
Right ascension of the Sun				276° 31′ 44″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				94° 9′ 29″	*from which*
subtract the distance from the meridian: right ascension of the comet				47° 54′ 23″	*sought*

18

Observation 9 [Obſervatio 9.]

From the comet's altitude of 42° 40′ 30″ in the west and azimuth of 87° 52′, observed in the morning at the true time of December 27, $12^{h}\ 48^{m}\ 15^{s}$.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		69			
Compl. of the altitude, log.		30761	*A.*		
Log. of the perpendicular	KG	30830		47° 16′ 35″	
Antilog. of the compl. of the altitude		38899			
Antilog. of the perpendicular	KG	38791	*S.*		
Antilog.	KF	108		2° 40′ 0″	*A*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			38° 17′ 8″	
Antilog.	KE	24216			
Antilog. of the perpendicular	GK	38791	*A*		
Antilog. of the compl. of the declination		63007		57° 49′ 20″	*complement to 90°*
is the declination itself sought				32° 10′ 40″	*North*
Log. of the perpendicular	KG	30830			
Log. of the hypotenuse	GE	16676	*S.*		

[18] the page prints KE as 47° 38′ 28″, the sum of 12° 1′ 28″ and 35° 37′ 8″ in the two lines above it; those two figures add to 47° 38′ 36″.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the angle	GEK	14154		60° 13′ 43″	*distance from the meridian*
Elongation from the meridian				192° 3′ 45″	
Right ascension of the Sun				276° 34′ 23″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				108° 38′ 8″	*from which*
subtract the distance from the meridian: right ascension of the comet				48° 24′ 25″	*sought*

19

Observation 10 [Obſervatio 10.]

From the comet's altitude of 41° 27′ in the west and azimuth of 89° 37′, observed in the morning at the true time of December 27, 12^{h} 55^{m} 45^{s}.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		2			
Log. of the compl. of the altitude		28830	*A.*		
Log. of the perpendicular	KG	28832		48° 33′ 0″	
Antilog. of the compl. of the altitude		41254			
Antilog. of the perpendicular	KG	41254	*S.*		
Antilog.	KF	0		0° 0′ 0″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			35° 37′ 8″	
Antilog.	KE	20713			
Antilog. of the perpendicular	GK	41254	*A.*		
Antilog. of the compl. of the declination		61967		57° 26′ 38″	*complement to 90°*
is the declination itself sought				32° 33′ 22″	*North*
Log. of the perpendicular	KG	28832			
Log. of the hypotenuse	GE	17096	*S.*		
Log. of the angle	GEK	11736		62° 46′ 52″	*distance from the meridian*
Elongation from the meridian				193° 48′ 45″	
Right ascension of the Sun				276° 34′ 42″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				110° 23′ 27″	*from which*
subtract the distance from the meridian: right ascension of the comet				47° 36′ 35″	*sought*

20

Observation 11 [Obſervatio 11.]

[19] the statement for Observation 9 stands at the foot of the left column, which closes with the column catchword "Log."; the calculation heads the right column.

[20] the stated time, 12^{h} 55^{m} 45^{s} at 15° to the hour, gives an elongation of 193° 56′ 15″; the page prints 193° 48′ 45″, which corresponds to 12^{h} 55^{m} 15^{s}. The sums below it are worked from the printed elongation.

From the comet's altitude of 39° 53′ 30″ in the west and azimuth of 91° 54′, observed in the morning at the true time of December 27, 1^h 8^m 15^s.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		55			
Log. of the compl. of the altitude		26493	*A.*		
Log. of the perpendicular	KG	26548		50° 4′ 15″	
Antilog. of the compl. of the altitude		44420			
Antilog. of the perpendicular	KG	44342	*S.*		
Antilog.	KF	78		2° 16′ 0″	*S.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			33° 21′ 8″	
Antilog.	KE	17995			
Antilog. of the perpendicular	GK	44342	*A.*		
Antilog. of the compl. of the declination		62337		57° 24′ 43″	*complement to 90°*
is the declination itself sought				32° 25′ 17″	*North*

21

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the perpendicular	KG	26548			
Log. of the hypotenuse	GE	16971	*S.*		
Log. of the angle	GEK	9577		65° 19′ 25″	*distance from the meridian*
Elongation from the meridian				197° 3′ 45″	
Right ascension of the Sun				276° 35′ 22″	
The sum, 360° thrown off, is the right ascension of the midheaven				113° 39′ 7″	*from which*
subtract the distance from the meridian: right ascension of the comet				48° 19′ 42″	*sought*

22

Observation 12 [Obſervatio 12.]

From the comet's altitude of 37° 27′ in the west and azimuth of 96° 19′, observed in the morning at the true time of December 27, 1^h 24^m 45^s.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		609			
Log. of the compl. of the altitude		23082	*A.*		
Log. of the perpendicular	KG	23691		52° 5′ 50″	

[21] the complement of 57° 24′ 43″ to 90° is 32° 35′ 17″; the page prints 32° 25′ 17″. The calculation for Observation 11 continues overleaf. Here the arc KF is tagged *S.* rather than *A.* and is subtracted from FE.

[22] these seven lines complete the calculation for Observation 11 begun on p. 73.

Line	Arc	Logarithm	Mark	Value	Remark
Antilog. of the compl. of the altitude		49747			
Antilog. of the perpendicular	KG	48722	*S.*		
Antilog.	KF	1025		8° 11′ 24″	*S.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			27° 25′ 44″	
Antilog.	KE	11914			
Antilog. of the perpendicular	KG	48722	*A.*		
Antilog. of the compl. of the declination		60636		56° 57′ 7″	*complement to 90°*
is the declination itself sought				33° 2′ 53″	*North*
Log. of the perpendicular	KG	23691			
Log. of the hypotenuse	GE	17648	*S.*		
Log. of the angle	GEK	6043		70° 17′ 0″	*distance from the meridian*
Elongation from the meridian				201° 11′ 15″	
Right ascension of the Sun				276° 36′ 1″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				117° 47′ 16″	*from which*
subtract the distance from the meridian: right ascension of the comet				47° 30′ 16″	*sought*

[23]

Observation 13 [Obſervatio 13.]

From the comet's altitude of 49° 51′ in the east and azimuth of 80° 39′, observed in the evening at the true time of December 27, $5^h\ 14^m\ 5^s$.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		1337			
Log. of the compl. of the altitude		43883	*A.*		
Log. of the perpendicular	KG	45220		39° 30′ 38″	
Antilog. of the compl. of the altitude		26872			
Antilog. of the perpendicular	KG	25941	*S.*		
Antilog.	KF	931		7° 49′ 30″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			43° 26′ 38″	
Antilog.	KE	31988			
Antilog. of the perpendicular	KG	25941	*A*		
Antilog. of the compl. of the declination		57929		55° 55′ 26″	*complement to 90°*
is the declination itself sought				34° 4′ 34″	
Log. of the perpendicular	KG	45220			
Log. of the hypotenuse	GE	18839	*S.*		
Log. of the angle	GEK	26381		50° 11′ 7″	

[23] the statement prints no minute mark after 27. The fifteenth line prints "Long." for "Log." The same antilogarithm, 1025, stands against 8° 11′ 24″ here and against 8° 12′ 24″ in Observation 14 below; each calculation is carried through with its own figure.

Line	Arc	Loga-rithm	Mark	Value	Remark
Elongation from the meridian				78° 31′ 15″	
Right ascension of the Sun				277° 19′ 58″	*A.*
The sum is the right ascension of the midheaven				355° 51′ 13″	
Its complement to 360°				4° 8′ 47″	
subtract it from the distance from the meridian: right ascension of the comet				46° 2′ 20″	*sought*

24

Observation 14 [Obſervatio 14.]

From the comet's altitude of 50° 26′ 30″ in the east and azimuth of 79° 58′, observed in the evening at the true time of December 27, 5^h 19^m 1^s.

Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the azimuth		1541			
Log. of the compl. of the altitude		45120	*A.*		
Log. of the perpendicular	KG	46661		38° 50′ 18″	
Antilog. of the compl. of the altitude		26010			
Antilog. of the perpendicular	KG	24985	*S.*		
Antilog.	KF	1025		8° 12′ 24″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			43° 49′ 32″	
Antilog.	KE	32659			
Antilog. of the perpendicular	KG	24985	*A.*		
Antilog. of the compl. of the declination		57644		55° 48′ 49″	*complement to 90°*
is the declination itself sought				34° 11′ 11″	*North*
Log. of the perpendicular	KG	46661			
Log. of the hypotenuse	GE	18970	*S.*		
Log. of the angle	GEK	27691		49° 18′ 5″	*distance from the meridian*
Elongation from the meridian				79° 45′ 15″	
Right ascension of the Sun				277° 20′ 12″	*A.*
The sum is the right ascension of the midheaven				357° 5′ 27″	
Its complement to 360°				2° 54′ 33″	
subtract the distance from the meridian: right ascension of the comet				46° 23′ 32″	*sought*

25

Observation 15 [Obſervatio 15.]

[24] the statement sets "Com." (of the comet) after the azimuth rather than after "altit." From this observation the comet is observed in the east, in the evening, and the calculation closes by taking the complement of the midheaven's right ascension to 360° from the distance from the meridian.

[25] the statement for Observation 14 stands at the foot of the left column, which closes with the column catchword "Log."; the calculation heads the right column. Its last line is worded as in Observations 2–12, though the figure is the distance less the complement.

From the comet's altitude of 51° 16′ in the east and azimuth of 78° 55′, observed in the evening at the true time of December 27, 5^h 23^m 58^s.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		1883			
Log. of the compl. of the altitude		46889	*A.*		
Log. of the perpendicular	KG	48772		37° 52′ 53″	
Antilog. of the compl. of the altitude		24838			
Antilog. of the perpendicular	KG	23687	*S.*		
Antilog.	KF	1151		8° 40′ 36″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			44° 17′ 44″	
Antilog.	KE	33444			
Antilog. of the perpendicular	KG	23687	*A*		
Antilog. of the compl. of the declination		57131		55° 36′ 46″	*complement to 90°*
is the declination itself sought				34° 23′ 14″	*North*
Log. of the perpendicular	KG	48772			
Log. of the hypotenuse	GE	19209	*S.*		
Log. of the angle	GEK	29563		48° 4′ 48″	*distance from the meridian*
Elongation from the meridian				80° 59′ 30″	
Right ascension of the Sun				277° 20′ 23″	
The sum is the right ascension of the midheaven				358° 19′ 53″	
Its complement to 360°				1° 40′ 7″	
subtract it from the distance from the meridian: right ascension of the comet				46° 24′ 41″	*sought*

Observation 16 [Obſervatio 16.]

From the comet's altitude of 52° 24′ in the east and azimuth of 77° 0′, observed in the evening at the true time of December 27, 5^h 33^m 39^s.

Line	Arc	Logarithm	Mark	Value	Re-mark
Log. of the azimuth		2596			
Log. of the compl. of the altitude		49407	*A.*		
Log. of the perpendicular	KG	52003		36° 28′ 36″	
Antilog. of the compl. of the altitude		23283			
Antilog. of the perpendicular	KG	21804	*S.*		
Antilog.	KF	1479		9° 49′ 48″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			45° 26′ 56″	

[26] the calculation for Observation 16 continues overleaf. On this page the tenth line of each full calculation prints KG where pp. 72–73 print GK.

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	KE	35447			
Antilog. of the perpendicular	KG	21804	*A*		
Antilog. of the compl. of the declination		57251		55° 39′ 36″	*complement to 90°*
is the declination itself sought				34° 20′ 24″	
Log. of the perpendicular	KG	52003			
Log. of the hypotenuse	GE	19153	*S.*		
Log. of the angle	GEK	32850		46° 3′ 16″	*distance from the meridian*
Elongation from the meridian				83° 24′ 45″	
Right ascension of the Sun				277° 20′ 52″	*A.*
The sum, 360° cast off, is the right ascension of the midheaven				0° 45′ 37″	
add the distance from the meridian: right ascension of the comet				46° 48′ 53″	*sought*

27

Observation 17 [Obſervatio 17.]

From the comet's altitude of 53° 33′ 30″ in the east and azimuth of 75° 14′, observed in the evening at the true time of December 27, 5^{h} 40^{m} 48^{s}.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		3359			
Log. of the compl. of the altitude		52127	*A*		
Log. of the perpendicular	KG	55486		35° 2′ 25″	
Antilog. of the compl. of the altitude		21758			
Antilog. of the perpendicular	KG	19996	*S.*		
Antilog.	KF	1762		10° 43′ 18″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			46° 20′ 26″	
Antilog.	KE	37052			
Antilog. of the perpendicular	GK	19996	*A.*		
Antilog. of the compl. of the declination		57048		55° 34′ 49″	*complement to 90°*
is the declination itself sought				34° 25′ 11″	*North*
Log. of the perpendicular	KG	55486			
Log. of the hypotenuse	GE	19248	*S.*		
Log. of the angle	GEK	36238		44° 6′ 30″	*distance from the meridian*
Elongation from the meridian				85° 12′ 0″	
Right ascension of the Sun				277° 21′ 12″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				2° 33′ 12″	
add the distance from the meridian: right ascension of the comet				46° 39′ 42″	*sought*

[27] these eleven lines complete the calculation for Observation 16 begun on p. 74.

28

Observation 18 [Obſervatio 18.]

From the comet's altitude of 55° 6′ in the east and azimuth of 72° 19′, observed in the evening at the true time of December 27, 5^h 50^m 9^s.

Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the azimuth		4840			
Log. of the compl. of the altitude		55836	*A*		
Log. of the perpendicular	KG	60676		33° 2′ 57″	
Antilog. of the compl. of the altitude		19827			
Antilog. of the perpendicular	KG	17648	*S*		
Antilog.	KF	2179		11° 55′ 0″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			47° 32′ 8″	
Antilog.	KE	39284			
Antilog. of the perpendicular	KG	17648	*A*		
Antilog. of the compl. of the declination		56932		55° 32′ 4″	*complement to 90°*
is the declination itself sought				34° 27′ 56″	*North*
Log. of the perpendicular	KG	60676			
Log. of the hypotenuse	GE	19302	*S.*		
Log. of the angle	GEK	41374		41° 23′ 20″	*distance from the meridian*
Elongation from the meridian				87° 32′ 15″	
Right ascension of the Sun				277° 21′ 39″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				4° 53′ 54″	
add the distance from the meridian: right ascension of the comet				46° 17′ 14″	*sought*

Observation 19 [Obſervatio 19.]

From the comet's altitude of 51° 52′ 40″ in the west and azimuth of 79° 36′, observed in the evening at the true time of December 27, 11^h 44^m 31^s.

Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the azimuth		1656			
Compl. of the altitude, log.		48226	*A.*		
Log. of the perpendicular	KG	49882		37° 24′ 35″	
Antilog. of the compl. of the altitude		23992			
Antilog. of the perpendicular	KG	23029	*S.*		
Antilog.	KF	963		7° 56′ 15″	*A*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			43° 33′ 23″	
Antilog.	KE	32201			
Antilog. of the perpendicular	GK	23029	*A*		
Antilog. of the compl. of the declination		55230		54° 51′ 24″	*complement to 90°*

[28] the statement prints "& Or. &", with an "&" before "Or." as well as after it.

Line	Arc	Logarithm	Mark	Value	Remark
is the declination itself sought				35° 8′ 36″	*North*
Log. of the perpendicular	KG	49882			
Log. of the hypotenuse	GE	20121	*S.*		
Log. of the angle	GEK	29761		47° 57′ 10″	*distance from the meridian*
Elongation from the meridian				176° 7′ 45″	
Right ascension of the Sun				277° 37′ 59″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				93° 45′ 44″	*from which*
subtract the distance from the meridian: right ascension of the comet				45° 48′ 34″	*sought*

29

Observation 20 [Obſervatio 20.]

From the comet's altitude of 50° 34′ 10″ in the west and azimuth of 81° 37′, observed in the evening at the true time of December 27, 11^h 52^m 31^s.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		1074			
Log. of the compl. of the altitude		45390	*A.*		
Log. of the perpendicular	KG	46464		38° 55′ 43″	
Antilog. of the compl. of the altitude		25826			
Antilog. of the perpendicular	KG	25112	*S.*		
Antilog.	KF	714		6° 50′ 20″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			42° 27′ 28″	
Antilog.	KE	30410			
Antilog. of the perpendicular	GK	25112	*A.*		
Antilog. of the compl. of the declination		55522		54° 58′ 27″	*complement to 90°*
is the declination itself sought				35° 1′ 33″	*North*
Log. of the perpendicular	KG	46464			
Log. of the hypotenuse	GE	19981	*S.*		
Log. of the angle	GEK	26483		50° 6′ 55″	*distance from the meridian*
Elongation from the meridian				178° 7′ 45″	
Right ascension of the Sun				277° 38′ 23″	*A.*
The sum, 360° thrown off, is the right ascension of the midheaven				95° 46′ 8″	*from which*
subtract the distance from the meridian: right ascension of the comet				45° 39′ 13″	*sought*

Observation 21 [Obſervatio 21.]

From the comet's altitude of 47° 31′ 40″ in the west and azimuth of 86° 25′, observed in the morning at the true time of December 28, 12^h 13^m 46^s.

[29] Observation 19 heads the right column; the left column closes with the column catchword "Ob-". Its sixth line has a small mark above the tag A.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		196			
Log. of the compl. of the altitude		39270	*A.*		
Log. of the perpendicular	KG	39466		42° 22′ 10″	
Antilog. of the compl. of the altitude		30434			
Antilog. of the perpendicular	KG	30270	*S.*		
Antilog.	KF	164		3° 17′ 0″	*A.*
Elevation of the equator, or	FE			35° 37′ 8″	
	KE			38° 54′ 8″	

30

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	KE	25075			
Antilog. of the perpendicular	GK	30270	*A.*		
Antilog. of the compl. of the declination		55345		54° 54′ 10″	*complement to 90°*
is the declination itself sought				35° 5′ 50″	*North*
Log. of the perpendicular	KG	39466			
Log. of the hypotenuse	GE	20068	*S.*		
Log. of the angle	GEK	19398		55° 27′ 17″	*distance from the meridian*
Elongation from the meridian				183° 26′ 30″	
Right ascension of the Sun				277° 39′ 22″*A.*	
The sum, 360° thrown off, is the right ascension of the midheaven				101° 5′ 52″	*from which*
subtract the distance from the meridian: right ascension of the comet				45° 38′ 35″	*sought*

31

Observation 22 [Obſervatio 22.]

From the comet's altitude of 18° 9′ 15″ in the west and azimuth of 49° 28′ counted from the north, observed in the morning at the true time of December 29, 3^{h} 50^{m} 52^{s}.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		27440			
Log. of the compl. of the altitude		5066			*corrected for refraction by subtracting 4′ 30″*
Log. of the perpendicular	KG	32506		46° 15′ 34″	
Antilog. of the compl. of the altitude		116989			
Antilog. of the perpendicular	KG	36904	*S.*		
Antilog.	KF	80085		63° 19′ 25″	

[30] the calculation for Observation 21 continues overleaf.
[31] these eleven lines complete the calculation for Observation 21 begun on p. 75.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			27° 42′ 17″	
Antilog.	KE	12177			
Antilog. of the perpendicular	KG	36904	*A*		
Antilog. of the compl. of the declination		49081		52° 15′ 23″	*complement to 90°*
is the declination itself sought				37° 44′ 37″	*North*
Log. of the perpendicular	KG	32506			
Log. of the hypotenuse	GE	23476	*S.*		
Log. of the angle	GEK	9030		66° 1′ 0″	*distance from the meridian*
Elongation from the meridian				237° 43′ 0″	
Right ascension of the Sun				278° 56′ 14″	
The sum, 360° thrown off, is the right ascension of the midheaven				156° 39′ 10″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				42° 40′ 10″	*sought*

[32]

Observation 23 [Obſervatio 23.]

From the comet's altitude of 17° 22′ in the west and azimuth of 48° 33′ counted from the north, observed in the morning at the true time of December 29, 3^{h} 55^{m} 52^{s}.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		28830			
Log. of the compl. of the altitude		4620	*A.*		*corrected for refraction by subtracting 5′ 0″*
Log. of the perpendicular	KG	33450		45° 42′ 0″	
Antilog. of the compl. of the altitude		121370			
Antilog. of the perpendicular	KG	35894	*S*		
Antilog.	KF	85476		64° 49′ 31″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			29° 12′ 23″	
Antilog.	KE	13598			
Antilog. of the perpendicular	KG	35894	*A.*		
Antilog. of the compl. of the declination		49492		52° 26′ 19″	*complement to 90°*
is the declination itself sought				37° 23′ 41″	*North*
Log. of the perpendicular	KG	33450			
Log. of the hypotenuse	GE	23230	*S.*		
Log. of the angle	GEK	10220		64° 32′ 0″	

[32] from this observation the azimuth is counted from the north, the altitude is corrected for refraction, and the arc KF exceeds FE: FE is tagged *S.* and subtracted from KF. The "complement" of the distance from the meridian taken in the last line is its difference from 180° (180° less 66° 1′ 0″ is 113° 59′ 0″, and 156° 39′ 10″ less that is 42° 40′ 10″).

Line	Arc	Log-a-rithm	Mark	Value	Remark
Elongation from the meridian				238° 58′ 0″	
Right ascension of the Sun				278° 56′ 24″	
The sum, 360° cast off, is the right ascension of the midheaven				157° 54′ 36″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				42° 26′ 26″	*sought*

[33]

Observation 24 [Obſervatio 24.]

From the comet's altitude of 14° 26′ in the west and azimuth of 44° 23′ counted from the north, observed in the morning at the true time of December 29, 4^{h} 28^{m} 50^{s}.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		35745			
Log. of the compl. of the altitude		3162			*corrected for refraction by subtracting 6′ 0″*
Log. of the perpendicular	KG	38907		42° 39′ 50″	
Antilog. of the compl. of the altitude		139609			
Antilog. of the perpendicular	KG	30740	*S.*		
Antilog.	KF	108869		70° 19′ 35″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			34° 42′ 27″	
Antilog.	KE	19592			
Antilog. of the perpendicular	KG	30740	*A.*		
Antilog. of the compl. of the declination		50332		52° 48′ 22″	*complement to 90°*
is the declination itself sought				37° 11′ 38″	*North*
Log. of the perpendicular	KG	38907			
Log. of the hypotenuse	GE	22741	*S.*		
Log. of the angle	GEK	16166		58° 17′ 27″	*distance from the meridian*
Elongation from the meridian				247° 12′ 30″	
Right ascension of the Sun				278° 57′ 54″	
The sum, 360° cast off, is the right ascension of the midheaven				166° 10′ 24″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				44° 27′ 52″	*sought*

Observation 25 [Obſervatio 25.]

From the comet's altitude of 12° 7′ in the west and azimuth of 39° 28′ counted from the north, observed in the morning at the true time of December 29, 4^{h} 47^{m} 49^{s}.

[33] the complement of 52° 26′ 19″ to 90° is 37° 33′ 41″; the page prints 37° 23′ 41″. Observation 23 stands at the foot of the left column, which closes with the column catchword "Ob-".

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		45314			
Log. of the compl. of the altitude		2203			*corrected for refraction by subtracting 8′ 0″*
Log. of the perpendicular	KG	47517		38° 26′ 33″	
Antilog. of the compl. of the altitude		157201			
Antilog. of the perpendicular	KG	24433	*S.*		
Antilog.	KF	132768		74° 37′ 40″	
Elevation of the equator, or the arc	FE			35° 37′ 8″	*S.*
	KE			39° 0′ 32″	
Antilog.	KE	25213			
Antilog. of the perpendicular	KG	24433	*A.*		
Antilog. of the compl. of the declination		49646		52° 31′ 15″	*complement to 90°*
is the declination itself sought				37° 28′ 45″	*North*
Log. of the perpendicular	KG	47517			
Log. of the hypotenuse	GE	23120	*S.*		
Log. of the angle	GEK	24397		51° 35′ 0″	
Elongation from the meridian				251° 57′ 15″	
Right ascension of the Sun				279° 58′ 48″	
The sum, 360° cast off, is the right ascension of the midheaven				170° 56′ 3″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				42° 31′ 3″	*sought*

34

Observation 26 [Obſervatio 26.]

From the comet's altitude of 20° 26′ 45″ in the west and azimuth of 46° 55′ counted from the north, observed in the morning at the true time of December 31, 3^{h} 37^{m} 26^{s}.

Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the azimuth		31422			
Log. of the compl. of the altitude		6507			*corrected for refraction, 3′ 15″ S.*
Log. of the perpendicular	KG	37929		43° 11′ 4″	
Antilog. of the compl. of the altitude		105176			
Antilog. of the perpendicular	KG	31587	*S.*		
Antilog.	KF	73589		61° 22′ 29″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			25° 45′ 21″	

[34] 279° 58′ 48″ and 251° 57′ 15″, 360° cast off, give 171° 56′ 3″; the page prints 170° 56′ 3″, and the last line is worked from the printed sum. The Sun's right ascension in Observations 22–24, of the same morning, is printed 278° 56′ 10″, 278° 56′ 26″ and 278° 57′ 55″.

35

Line	Arc	Log-a-rithm	Mark	Value	Remark
Antilog.	KE	10462			
Antilog. of the perpendicular	KG	31587	*A*		
Antilog. of the compl. of the declination		42049		48° 56′ 53″	*complement to 90°*
is the declination itself sought				41° 3′ 7″	*North*
Log. of the perpendicular	KG	37929			
Log. of the hypotenuse	GE	28222	*S.*		
Log. of the angle	GEK	9707		65° 9′ 45″	*distance from the meridian*
Elongation from the meridian				234° 21′ 30″	
Right ascension of the Sun				281° 8′ 20″	*A.*
The sum, 360° cast off, is the right ascension of the midheaven				155° 29′ 50″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				40° 39′ 35″	*sought*

36

Observation 27 [Obfervatio 27.]

From the comet's altitude of 19° 44′ in the west and azimuth of 45° 56′ counted from the north, observed in the morning at the true time of December 31, 3^{h} 44^{m} 24^{s}.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		33055			
Log. of the compl. of the altitude		6013			*corrected for refraction, 3′ 45″ S.*
Log. of the perpendicular	KG	39068		42° 34′ 44″	
Antilog. of the compl. of the altitude		108883			
Antilog. of the perpendicular	KG	30604	*S.*		
Antilog.	KF	78279		62° 47′ 56″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			27° 10′ 48″	
Antilog.	KE	11699			
Antilog. of the perpendicular	GK	30604	*A.*		
Antilog. of the compl. of the declination		42303		49° 4′ 32″	*complement to 90°*
is the declination itself sought				40° 55′ 28″	*North*
Log. of the perpendicular	KG	39068			
Log. of the hypotenuse	GE	28028	*S.*		

[35] the calculation for Observation 26 continues overleaf. Observation 24 heads the right column.

[36] these eleven lines complete the calculation for Observation 26 begun on p. 76.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the angle	GEK	11040		63° 34′ 10″	*distance from the meridian*
Elongation from the meridian				236° 6′ 0″	
Right ascension of the Sun				281° 8′ 39″	*A.*
The sum, 360° cast off, is the right ascension of the midheaven				157° 14′ 39″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				40° 48′ 49″	*ought*

Observation 28 [Obſervatio 28.]

From the comet's altitude of 15° 41′ 30″ in the west and azimuth of 38° 7′ counted from the north, observed in the morning at the true time of December 31, 4^{h} 27^{m} 22^{s}.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		48246			
Log. of the compl. of the altitude		3753			*corrected for refraction, 5′ 30″ S.*
Log. of the perpendicular	KG	51999		36° 28′ 41″	
Antilog. of the compl. of the altitude		131334			
Antilog. of the perpendicular	KG	21807	*S*		
Antilog.	KF	109527		70° 27′ 46″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			34° 50′ 38″	
Antilog.	KE	19756			
Antilog. of the perpendicular	KG	21807	*A*		
Antilog. of the compl. of the declination		41563		48° 42′ 20″	*complement to 90°*
is the declination itself sought				41° 17′ 40″	*North*
Log. of the perpendicular	KG	51999			
Log. of the hypotenuse	GE	28592	*S.*		
Log. of the angle	GEK	23407		52° 18′ 25″	*distance from the meridian*
Elongation from the meridian				246° 50′ 30″	
Right ascension of the Sun				281° 10′ 40″	*A.*
The sum, 360° cast off, is the right ascension of the midheaven				168° 1′ 10″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				40° 19′ 35″	*ought*

Observation 29 [Obſervatio 29.]

From the comet's altitude of 30° 14′ in the west and azimuth of 57° 58′ counted from the north, observed in the morning at the true time of 1653 January 1, 2^{h} 15^{m} 40^{s}.

Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the azimuth		16518			
Log. of the compl. of the altitude		14620	*A.*		
Log. of the perpendicular	KG	31138		47° 5′ 30″	
Antilog. of the compl. of the altitude		68613			
Antilog. of the perpendicular	KG	38444	*S.*		
Antilog.	KF	30169		42° 18′ 22″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			6° 41′ 14″	
Antilog.	KE	682			
Antilog. of the perpendicular	GK	38444	*A*		
Antilog. of the compl. of the declination		39126		47° 27′ 8″	*complement to 90°*
is the declination itself sought				42° 32′ 52″	*North*
Log. of the perpendicular	KG	31138			
Log. of the hypotenuse	GE	30556	*S.*		
Log. of the angle	GEK	582		83° 49′ 20″	*distance from the meridian*
Elongation from the meridian				213° 55′ 0″	
Right ascension of the Sun				282° 11′ 15″	*A.*
The sum, 360° cast off, is the right ascension of the midheaven				136° 6′ 15″	*from which*
subtract the distance from the meridian: right ascension of the comet				39° 55′ 35″	*sought*

37

Observation 30 [Obſervatio 30.]

From the comet's altitude of 29° 29′ 45″ in the west and azimuth of 56° 50′ counted from the north, observed in the morning at the true time of January 1, $2^{h}\ 20^{m}\ 43^{s}$.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		17783			
Log. of the compl. of the altitude		13835	*A.*		
Log. of the perpendicular	KG	31618		46° 47′ 44″	
Antilog. of the compl. of the altitude		70842			
Antilog. of the perpendicular	KG	37891	*S.*		
Antilog.	KF	32951		44° 0′ 18″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			8° 23′ 10″	
Antilog.	KE	1074			
Antilog. of the perpendicular	GK	37891	*A.*		

[37] the last line's label reads ”subtract the distance from the meridian”, without ”complement”; the figure printed is worked with the complement (180° less 83° 49′ 20″ is 96° 10′ 40″, and 136° 6′ 15″ less that is 39° 55′ 35″), as in the neighbouring observations. From this observation the second line carries the tag *A.* and no refraction remark.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Antilog. of the compl. of the declination		38965		47° 22′ 0″	*complement to 90°*
is the declination itself sought				42° 38′ 0″	*North*
Log. of the perpendicular	KG	31618			
Log. of the hypotenuse	GE	30693	*S.*		
Log. of the angle	GEK	925		82° 13′ 0″	*distance from the meridian*
Elongation from the meridian				215° 10′ 45″	
Right ascension of the Sun				282° 11′ 27″	*A.*
The sum, 360° cast off, is the right ascension of the midheaven				137° 22′ 12″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				39° 35′ 12″	*sought*

Observation 31 [Obſervatio 31.]

From the comet's altitude of 28° 58′ in the west and azimuth of 56° 3′ counted from the north, observed in the morning at the true time of January 1, 2^{h} 24^{m} 55^{s}.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the azimuth		18690			
Log. of the compl. of the altitude		13364	*A.*		
Log. of the perpendicular	KG	32054		46° 32′ 0″	
Antilog. of the compl. of the altitude		72505			
Antilog. of the perpendicular	KG	37406	*S.*		
Antilog.	KF	35099		45° 15′ 6″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			9° 37′ 58″	

38

Line	Arc	Log-a-rithm	Mark	Value	Remark
Antilog.	KE	1415			
Antilog. of the perpendicular	GK	37406	*A.*		
Antilog. of the compl. of the declination		38821		47° 17′ 30″	*complement to 90°*
is the declination itself sought				42° 42′ 30″	*North*
Log. of the perpendicular	KG	32054			
Log. of the hypotenuse	GE	30814	*S.*		
Log. of the angle	GEK	1240		80° 59′ 30″	*distance from the meridian*

[38] the calculation for Observation 31 continues overleaf. Observation 29 heads the right column; the left column closes with the column catchword "Ob-".

Line	Arc	Log-a-rithm	Mark	Value	Remark
Elongation from the meridian				216° 13′ 45″	
Right ascension of the Sun				282° 11′ 38″	*A.*
The sum, 360° cast off, is the right ascension of the midheaven				138° 25′ 23″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				39° 24′ 53″	*sought*

39

Observation 32 [Obſervatio 32.]

From the comet's altitude of 21° 57′ in the west and azimuth of 46° 10′ counted from the north, observed in the morning at the true time of January 1, $3^h\ 26^m$.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		32662			
Log. of the compl. of the altitude		7495			*corrected for refraction by subtracting 2′ 35″*
Log. of the perpendicular	KG	40157		42° 0′ 42″	
Antilog. of the compl. of the altitude		98591			
Antilog. of the perpendicular	KG	29703	*S.*		
Antilog.	KF	68888		59° 51′ 31″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			24° 14′ 23″	
Antilog.	KE	9229			
Antilog. of the perpendicular	KG	29703	*A*		
Antilog. of the compl. of the declination		38932		47° 21′ 0″	*complement to 90°*
is the declination itself sought				42° 39′ 0″	*North*
Log. of the perpendicular	KG	40157			
Log. of the hypotenuse	GE	30720	*S.*		
Log. of the angle	GEK	9437		65° 30′ 0″	*distance from the meridian*
Elongation from the meridian				231° 30′ 0″	
Right ascension of the Sun				282° 15′ 8″	
The sum, 360° cast off, is the right ascension of the midheaven				153° 45′ 8″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				39° 15′ 8″	*sought*

Observation 33 [Obſervatio 33.]

From the comet's altitude of 20° 4′ 30″ in the west and azimuth of 43° 9′ counted from the north, observed in the morning at the true time of January 1, $3^h\ 44^m\ 16^s$.

[39] these eleven lines complete the calculation for Observation 31 begun on p. 77.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		37993			
Log. of the compl. of the altitude		6231	*A.*		*corrected for refraction by subtracting 3′ 30″*
Log. of the perpendicular	KG	44224		39° 59′ 0″	
Antilog. of the compl. of the altitude		107209			
Antilog. of the perpendicular	KG	26627	*S*		
Antilog.	KF	80582		63° 28′ 0″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			27° 50′ 52″	
Antilog.	KE	12310			
Antilog. of the perpendicular	GK	26627	*A.*		
Antilog. of the compl. of the declination		38937		47° 21′ 10″	*complement to 90°*
is the declination itself sought				42° 38′ 50″	*North*
Log. of the perpendicular	KG	44224			
Log. of the hypotenuse	GE	30720	*S.*		
Log. of the angle	GEK	13504		60° 54′ 0″	
Elongation from the meridian				236° 4′ 0″	
Right ascension of the Sun				282° 15′ 58″	*E.*
The sum, 360° cast off, is the right ascension of the midheaven				158° 19′ 58″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				39° 13′ 58″	*sought*

40

Observation 34 [Obſervatio 34.]

From the comet's altitude of 26° 42′ 15″ in the west and azimuth of 46° 37′ counted from the north, observed in the morning at the true time of January 4, 2^{h} 39^{m} 10^{s}.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		31914			
Log. of the compl. of the altitude		11275			*corrected for refraction by subtracting 45″*
Log. of the perpendicular	KG	41389		40° 29′ 13″	
Antilog. of the compl. of the altitude		80002			
Antilog. of the perpendicular	KG	27370	*S.*		
Antilog.	KF	52632		53° 47′ 16″	
Elevation of the equator, or	FE			35° 37′ 8″	*S.*
	KE			18° 10′ 8″	
Antilog.	KE	5114			
Antilog. of the perpendicular	KG	27370	*A.*		

[40] the first twelve lines of this calculation close the left column; the last seven head the right column.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Antilog. of the compl. of the declination		32484		43° 43′ 34″	*complement to 90°*
is the declination itself sought				46° 16′ 26″	*North*
Log. of the perpendicular	KG	43189			
Log. of the hypotenuse	GE	36931	*S.*		
Log. of the angle	GEK	6258		69° 56′ 27″	
Elongation from the meridian				219° 47′ 30″	
Right ascension of the Sun				285° 31′ 5″	*A*
The sum, 360° cast off, is the right ascension of the midheaven				145° 18′ 35″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				35° 15′ 2″	*sought*

41

Observation 35 [Obſervatio 35.]

From the comet's altitude of 24° 57′ in the west and azimuth of 45° 13′ counted from the north, observed in the morning at the true time of January 4, $2^h\ 53^m\ 30^s$.

Line	Arc	Log-a-rithm	Mark	Value	Remark
Log. of the azimuth		34281			
Log. of the compl. of the altitude		9783			*corrected for refraction by subtracting 1′ 0″*
Log. of the perpendicular	KG	44064		40° 3′ 43″	
Antilog. of the compl. of the altitude		86378			
Antilog. of the perpendicular	KG	26742	*S.*		
Antilog.	KF	59636		56° 34′ 40″	
Elevation of the equator, or the arc	FE			35° 37′ 8″	*S.*
	KE			20° 57′ 32″	
Antilog.	KE	6845			
Antilog. of the perpendicular	KG	26742	*A.*		
Antilog. of the compl. of the declination		33587		44° 22′ 46″	*complement to 90°*
is the declination itself sought				45° 37′ 14″	*North*
Log. of the perpendicular	KG	44064			
Log. of the hypotenuse	GE	35752	*S.*		
Log. of the angle	GEK	8312		66° 57′ 40″	*distance from the meridian*
Elongation from the meridian				224° 52′ 30″	
Right ascension of the Sun				285° 32′ 2″	*A.*
The sum, 360° cast off, is the right ascension of the midheaven				150° 24′ 32″	*from which*
subtract the complement of the distance from the meridian: right ascension of the comet				37° 22′ 12″	*sought*

41 31914 and 11275 sum to 43189, the figure printed for the perpendicular KG in the thirteenth line; the third line prints 41389. The rest of the calculation is worked from 43189 (43189 less 36931 is 6258).

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Section V. To Find the Comet's Longitudes and Latitudes from Its Distances from Various Fixed Stars, and to Check Them [SECTIO V. Ex diſtantiis Cometæ à diverſis Stellis Fixis, Longitudines, & Latitudines ejus indagare, eaſq; examinare.]

[Margin: Quâ methodo longitudines & latitudines Cometæ ex diſtantiis ſint ſupputatæ.] [By what method the comet's longitudes and latitudes are computed from its distances.]

In the preceding Section the comet's declinations and right ascensions were computed from its given altitudes and azimuths. In a similar way, in this chapter we shall try to find the comet's longitudes and latitudes, that is, its true place with respect to the ecliptic, as accurately as can ever be done, from the very sources of trigonometry, using the comet's distances from various fixed stars, taken by us both with the sextant and with the radius. Since, however, this business is of far greater moment and calls for deeper inquiry, and the calculation is moreover much more laborious and intricate, because of the various cases and the very diverse triangles to be solved, I consider it supremely necessary that each example be demonstrated and computed from its own particular diagram. Next, I consider it necessary also that whatever longitudes and latitudes of the comet are found be checked by other, different distances of stars from the comet, provided sufficient observations are not lacking, so that we may see whether some error has crept in on us, in the calculation or even in the observation itself. This can very aptly be done by this method.

[Margin: Quâ ratione quodlibet exēplum ſit examinatum.] [How each example is checked.]

For once the comet's longitude and latitude have been found, for example from the comet's distances from the right shoulder of Orion and the upper horn of Taurus, let the distance between the comet and Aldebaran [Aldeboræ] likewise be sought by calculation, given, namely, the comet's longitude and latitude and also the longitude and latitude of Aldebaran (though the distance between the comet and Palilicium must no less have been observed at that same time). Does this computed distance also agree entirely with the other, observed one, or not? If these distances agree, apart from a very few minutes, that is an infallible proof both that the observations themselves were duly made and that the comet's place was rightly established. But if the difference between the said distances is of some moment, amounting, that is, to many minutes, it is a sure sign that there has been an error, either in the observation or in the calculation; and for that reason that example must be either corrected or rejected outright.

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[42] the stated time, $2^h\ 53^m\ 30^s$, gives an elongation of 223° 22′ 30″; the page prints 224° 52′ 30″, which answers to $2^h\ 59^m\ 30^s$. The last two lines are worked from the printed elongation.

[43] the left column closes with the column catchword "Log."; the lower third of the page is blank.

[Margin: Artis fuit Cometā an. 1652 accuratè dimetiri, & quare?] [It took skill to measure the comet of 1652 accurately; and why?]

Indeed, such doubtful observations have sometimes easily crept in, and this is no cause for wonder. Very often not only the vaporous air but also the comet, dim in its light, and its huge head, diffused in rays, prevented it from being observed with complete accuracy at all times and its centre from always being rightly grasped. Hence it truly takes skill, as all practised observers will admit even without my saying so, always to determine comets correctly, unless they are observed with larger instruments, and also by the most practised investigators of the heavens. Yet you will see, my reader, with what diligence our observations (be it said without boasting) were carried out, and how they agree with one another. You will certainly be astonished that, amid such difficulty and subtlety in these matters, everything could be determined so precisely.

[Margin: Tribus obſervationibus opus habemus ad longitudines exquiſitè indagandas.] [We need three observations to find the longitudes exactly.]

When, however, the calculation is to be set up and checked in the way I reported above, three observations of the comet's distances from fixed stars, taken at the same time, must be at hand. From two the longitude and latitude are indeed derived; but in no way is a check made from two observations alone. It is true that in the first example below the longitudes and latitudes were checked from only two distances; but we approached that task by an entirely different method, because at the time of the observation the comet formed a nearly straight line together with two other fixed stars, as we noted near the beginning of Sect. I, the general description.

[Margin: In primâ obſervatione Cometa triangulum æquilaterum conſtituit.] [In the first observation the comet formed an equilateral triangle.]

As for the first observation, from which the comet's longitude and latitude are to be derived, it was made on December 20, at about seven in the evening. At that time, as the figure of the observation itself attests, the comet formed a nearly equilateral triangle with Regel [Rigel], a star of the first magnitude, and the star above the foot of Orion in the river, of the third magnitude. At the same time it also lay roughly on a straight line with two other fixed stars, namely the preceding one in Eridanus and the following one of the two upper ones, according to Tycho. Nearly equilateral, I say, was the triangle the comet formed: for with the radius the distance between the comet and Regel was taken as 3° 7′, and that between the star above Orion's foot and the comet as 3° 25′, while the distance between Regel and the star above Orion's foot is 3° 33′. From these observations, with the help of the figure set beside them, let us now investigate as best we can the comet's true place with respect to the ecliptic.

[Margin: Methodus ſupputandi longitudines & latitudines Cometæ] [Method of computing the comet's longitudes and latitudes]

Diagram. An engraved figure set to the left of the numbered steps. A curved line across the top, labelled "Ecliptica." (the ecliptic), carries the points

G, E, D, O, P from left to right, with the sign of Aries at its right end. Five circles of latitude run down from G, E, D, O and P and converge at A, at the foot of the figure. Three stars and the comet are marked on them: B, labelled "Regel." (Rigel), on the line from G; C, labelled "Sup. ped. Or." (above the foot of Orion), on the line from E; the comet, drawn as a small circle labelled "Cometa" with F just below it, on the line from D; K, labelled "Se[[q/g]]. duar. ſup." (the following [?] of the two upper ones), on the line from O; and L, labelled "Præc. in Er." (the preceding one in Eridanus), on the line from P. Solid lines join B, C and the comet in a triangle, and run from the comet through K to L. Dotted lines run from B to H, from I to the comet, from the comet towards N, and from K towards M. Below A stands the engraver's note "Autor Sculpsit." (the author engraved it).

- G, E, D, O, P (top, along the ecliptic, left to right): points on the ecliptic
- ♈ (top right, end of the ecliptic): the sign of Aries
- Ecliptica. (top, above D): the ecliptic
- A (foot): the south pole of the ecliptic, where the circles of latitude meet
- B (left), Regel.: Rigel
- C (upper left), Sup. ped. Or.: the star above the foot of Orion
- F (centre), Cometa: the comet
- H (left of centre, below the dotted line from B): foot of the perpendicular B H
- I (left of the comet, on the line from E): point on the dotted line to the comet
- K (right of centre): star labelled "Se[[q/g]]. duar. ſup." [?]
- L (upper right): star labelled "Præc. in Er."
- M (right, below K): point on the dotted line from K
- N (lower right): point on the dotted line from the comet
- Autor Sculpsit. (below A): the engraver's note

1. Let A, then, be the south pole of the ecliptic; ♈ D E G the ecliptic itself; A D, A E, A G circles of latitude; and B Rigel, C the star above the foot of Orion, and F the comet, together forming that equilateral triangle. First, in triangle A C B, the perpendicular B H is to be found from the complement of Rigel's latitude, taken as hypotenuse, and from the angle H A B, or E A B, of the opposite side, which is measured by the difference E G of the stars' longitudes, namely ♈ E of the star above Orion's foot and ♈ G of Rigel. This is very easily done, for the sum of the logarithms of the two given quantities is the logarithm of the perpendicular H B sought.
2. In the right triangle A H B, let A H be sought, given the hypotenuse A B, the complement of Rigel's latitude, and the perpendicular H B just found, in this way: the antilogarithm of the side, subtracted from the antilogarithm of the hypotenuse, leaves the antilogarithm of the side

sought, A H. If you subtract this side A B from the complement of the latitude of the fixed star above Orion's foot, you will have H C.[44]

[Margin: Ratio cal- culi.] [The calculation.]

3. In the smaller triangle H C B, the distance between the fixed star above Orion's foot, C, and Rigel, B, must also be sought at the same time, together with the angle H C B. That distance C B, the hypotenuse of the same triangle, is found from the sum of the antilogarithms of the two remaining sides: H C, just found, and the perpendicular H B. The acute angle H C B, in turn, comes out of the logarithm that remains when the logarithm of the hypotenuse C B is subtracted from the logarithm of the side H B.
4. In the larger, equilateral triangle F C B, let the angle F C B be derived from the three given sides in the usual way. The difference of the two sides that enclose the angle sought is added to the third side and subtracted from it. From the aggregate of the logarithms of the half-sum and of the half-remainder, subtract the aggregate of the logarithms belonging to the two sides mentioned above (those enclosing the angle sought); half the remainder is the logarithm of half the angle sought. Then subtract the angle H C B, found above, from the whole angle F C B, and the angle F C A will remain.
5. In triangle A F C the perpendicular F I is sought again, given the angle F C A and the hypotenuse F C, as above under number 1. In turn, the side C I is also found from the two sides F C and the perpendicular F I, in the same way as was done under number 2. From this side C I let A C, the complement of the latitude of the star above Orion's foot, then be subtracted, so as to give I A.[45]
6. Finally, in triangle F A I, given the two sides F I and I A that enclose the right angle, let the hypotenuse F A be found, as you see done likewise under number 3. This hypotenuse is at the same time the complement of the comet's latitude sought. Once it is found, seek in the same triangle the acute angle F A I, in exactly the same way as we did under the same number 3, knowing, that is, the side F I, opposite the angle sought, and the hypotenuse A F, the complement of the comet's latitude. In this case (since the comet is more westerly) let this angle F A I, or D A E, be subtracted from the longitude of the fixed star above Orion's foot, ♈ E; the remainder, ♈ D, is the comet's longitude sought. For example:

Observation I. [Obſervatio I.]

[44] the last sentence prints "Quod latus A B", "this side A B"; the side just found is A H, and in the figure H C is the part of A C below C, A C being the complement of that star's latitude.

[45] the page prints the subtraction this way round; in the calculation overleaf C I, 2° 56′ 0″, is taken from A C, 62° 6′ 0″, leaving I A, 59° 10′ 0″.

Given the comet's distances from Rigel, 3° 7′, and from the fixed star above the foot of Orion, 3° 25′ [?], taken on December 20 at about 7 in the evening, let the comet's longitude and latitude be sought.[46]

Quantity	Value	Quantity	Value	Quantity	Value
Longitude of Rigel	72° 1′ 12″	Latitude of Rigel	31° 10′ 40″	Latitude of the star above Orion's foot	27° 54′
Longitude of the star above Orion's foot	70° 26′ 12″	Quadrant of the circle	89° 59′ 60″	Quadrant of the circle	89° 60′
Difference, angle E A G	1° 35′ 0″	Compl. of the latitude of Rigel	58° 49′ 20″	Compl. of the latitude of the star	62° 6′

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Step	Line	Arc	Loga-rithm	Mark	Value	Remark
1	Log. of the compl. of the latitude of Rigel	A B	15599			
	Log. of the angle	E A G	358882	*A.*		
	Log. of the perpendicular	B H	374481		1° 21′ 14″	
2	Antilog. of the compl. of the latitude of Rigel	A B	65837			
	Antilog. of the perpendicular	B H	28	*S.*		
	Antilog.	H A	65809		58° 4[?]′ 45″	
		C A			62° 6′ 0″	
		C H			3° 17′ 15″	
3	Antilog.	C H	164			
	Antilog. of the perpendicular	B H	28	*A*		
	Antilog. of the distance	C B	192			*Rigel and the star above the foot*
	Log. of the perpendicular	B H	374481		3° 33′	
	Log. of the distance	C B	278192	*S.*		
	Log. of the angle	H C B	96289		22° 26′ 39″	

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[46] the mark after "25" is faint and is not separated between ′ and ″; the preceding page gives this distance as 3° 25′.

[47] the three groups stand side by side across the page; "the star" in the third group is printed as an asterisk, as also in the step-3 remark below.

[48] the left-hand column of the calculation. The value 3° 33′ stands one line below the antilogarithm 192 to which it belongs, opened by a square bracket. In the minutes of H A the second figure is not separated between 3 and 8 on the page, so the value reads either 58° 43′ 45″ or 58° 48′ 45″.

Step	Line	Value	Logarithm	Mark	Remark
4	Side C B	3° 33′	278192		
	Side F C	3° 25′	282015	*A.*	
	Difference	8′	560207		*first aggregate*
	Side F B	3° 7′			
	Sum	3° 15′			
	Half	1° 37½′	356286		
	Difference	2° 59′			
	Half	1° 29½′	364846	*A.*	
	Second aggregate		721132		
	First aggregate		560207	*S.*	
	Remainder		160925		

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Step	Line	Arc	Logarithm	Mark	Value	Remark
5	Half		80462		26° 34′ 4″	*half-angle*
	Whole angle	F C B			53° 8′ 8″	
	The angle was	H C B			22° 26′ 39″	*S.*
	Angle	F C A			30° 41′ 29″	
	Log.	F C	282015			
	Log. of the angle	F C A	67254	*A.*		
	Log. of the perpendicular	F I	349269		1° 44′ 35″	
	Antilog.	F C	178			
	Antilog. of the perpendicular	F I	47	*S.*		
	Antilog.	C I	131		2° 56′ 0″	
	Compl. of the latitude of the star above the foot	A C			62° 6′ 0″	
		I A			59° 10′ 0″	

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Step	Line	Arc	Logarithm	Mark	Value	Remark
6	Antilog. of the perpendicular	F I	47			
	Antilog.	I A	66837	*A.*		
	Antilog. of the compl. of the latitude	F A	66884		59° 10′ 59″	*compl. of the latitude of the comet*

[49] the right-hand column of the calculation; each logarithm in the first, second, sixth and eighth rows is preceded by "Log." on the page.

[50] the left-hand column of the calculation, continued from the preceding page. In the half-angle the first figure of the minutes is a partly inked sort, a 3 (its upper bowl is faint); "the star" is printed as an asterisk.

Step	Line	Arc	Loga-rithm	Mark	Value	Remark
	Therefore the latitude of the comet sought				30° 49′ 1″	D F
	Log. of the perpendicular	F I	349269			
	Log.	F A	15221	*S.*		
	Log. of the angle	F A I	334048		2° 1′ 48″	*S.*
	Longitude of the star above the foot of Orion	♈ E			70° 26′ 12″	
	Longitude of the comet sought	♈ D			8° 24′ 24″ ♊	

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[Margin: Examen cal- culi.] [Checking the calculation.]

Having thus found the comet's longitude and latitude, let us test whether its place has been rightly determined. We do so from the fact that at that time, while the comet formed an equilateral triangle, it also lay on a nearly straight line with two other stars: L, the preceding one in Eridanus, of the fifth magnitude, and K, the following one of the two upper ones, of the fourth magnitude. This will become plain if, in the same figure on the preceding page, the angle M L K is found first, in the right triangle K L M, and then also the angle N L F in the triangle F L N, which is likewise right-angled. If these angles are found to be entirely equal, we judge quite rightly that the comet stood on a straight line with those fixed stars, and consequently also that its place has been duly determined. But if the angles are found to be unequal, and the second is the smaller, you may know that the comet deviated from the straight line towards the south; if, however, it is the larger, towards the north; and by as many degrees and minutes as the said angles differ from each other. From this we also safely conclude that there has been some error in the longitude and latitude.

[Margin: Genuinum in- dicium Come- tam cum dua- bus fixis in re- ctâ ſtetiſſe li- neâ.] [A genuine sign that the comet stood on a straight line with two fixed stars.]

1. In the obtuse-angled triangle L A K, let the perpendicular K M and the side A M be sought, given namely A K, the complement of the latitude of the following star of the two others in Eridanus, and the angle L A K, or P A O, the difference of the longitudes of the two stars L and K, in exactly the way that was done under numbers 1 and 2. Then let A M be subtracted from the complement of the latitude, A L, so that M L remains. And so, in the triangle M L K, from the two sides enclosing the right angle, let the angle M L K sought be found by this rule: the logarithm of the side adjacent to the angle sought, taken as defective and added (algebraically, if need be) to the mesologarithm [Meſologarithmo] of the remaining side, gives the mesologarithm of the angle sought.

51 the right-hand column of the calculation. "the star" is printed as an asterisk.

2. By exactly the same method, in the triangle L A F, given A F, the complement of the comet's latitude found in the calculation above, and the angle L A F, the difference in longitude between the comet, ♈ D, and the preceding star in Eridanus, ♈ P, let F N be sought, together with N L, and finally also, as before, the angle N L F sought. For example:

Step	Line	Arc	Logarithm	Mark	Value	Remark
1	Longitude of the fixed star L, or	♈ P			64° 29′ 42″	
	Longitude of the fixed star K, or	♈ O			66° 13′ 42″	
	Difference P O, or the angle				1° 44′ 0″	L A K
	Latitude of the fixed star K, or	O K			27° 51′ 0″	
					89° 60′ 0″	
	Compl. of the latitude of K, or	A K			62° 9′ 0″	
	Latitude of the fixed star L, or	P L			25° 34′ 0″	
					89° 60′ 0″	
	Compl. of the latitude of L, or	A L			64° 26′ 0″	
	Log. of the compl. of the latitude of K		12310			
	Log. of the angle	L A K	349833	*A.*		
	Log. of the perpendicular	K M	362143		1° 31′ 58″	
	Antilog. of the compl. of the latitude of K		76109			
	Antilog. of the perpendicular	K M	36	*S.*		
	Antilog.	A M	76073		62° 8′ 21″	
	Compl. of the latitude of L, or	A L			64° 26′ 0″	
	Side	M L			2° 17′ 39″	
	Log.	M L	321813			*subtr. coss.*
	Mesolog.	M K	361010			
	Mesol. of the angle	M L K	39197		34° 2′ 55″	*sought*

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Step	Line	Arc	Logarithm	Mark	Value	Remark
2	Longitude of the fixed star L, or	♈ P			64° 29′ 42″	
	Longitude of the comet F, or	♈ D			68° 24′ 24″	*was found*
	Difference P D, or the angle	L A F			3° 54′ 42″	
	Latitude of the comet	F D			30° 49′ 1″	
	Compl. of the latitude of the comet				59° 10′ 59″	A F
	Log. of the compl. of the latitude of the comet F		15221			
	Log. of the angle	P A D	268504	*A.*		
	Log. of the perpendicular	F N	283725		3° 21′ 31″	
	Antilog. of the compl. of the latitude of F		66886			

[52] the left-hand column of the check calculation.

Step	Line	Arc	Loga-rithm	Mark	Value	Remark
	Antilog. of the perpendicular	F N	171	*S.*		
	Antilog.	A N	66715		59° 7′ 30″	
	Compl. of the latitude of L, or	A L			64° 26′ 0″	
	Side	L N			5° 18′ 30″	
	Log.	L N	238039			*sub. coss., that is, S.*
	Mesologarithm	F N	283563			
	Mesol. of the angle	N L F	45524		32° 23′ 12″	
	The angle M L K was found to be				34° 2′ 55″	
	Difference of the angles, only				1° 39′ 43″	

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This discrepancy is certainly of no moment. For if you set up the calculation correctly, and from the angle M L K found first you duly seek the comet's latitude, it will be evident that at that time the comet deviated from the straight line by no more than 5′, or at most 6′. This could hardly be discerned, especially because of the comet's huge head, which was nearly the size of the Moon. Hence it is known that the comet's place on this day was found accurately enough, even though the observation was made only with the radius and that straight line was judged by us with the naked eye.

Observation 2. [Obfervatio 2.]

Given the comet's distances from the right shoulder of Orion, 28° 22′, and from the upper horn of Taurus, 20° 27′, taken on December 23 at about 10^{h} 15^{m} in the evening, let the comet's longitude and latitude be sought.

Diagram. An engraved figure set to the right of the prose, within a faint rectangular frame. A nearly horizontal line, the ecliptic, runs across the upper part from C at the left to the sign of Aries at the right, with I, H, R, N, G marked above it from left to right. Several lines run down from the ecliptic and converge at A at the foot. Stars, drawn as small asterisks, stand at E (top, labelled "Cornu ♉", the horn of Taurus), D (left, labelled "Humer. luc. Or.", the bright shoulder of Orion, set vertically along the line below it), M (labelled "Palilic.", Palilicium) and P (labelled "Regel.", Rigel). The comet is a small circle at F, labelled "Cometa", just below the ecliptic near G. Solid lines join E to D, E through N to F, D to F, F to M and F to P; dotted lines run from D to K, from the line through H to F, from M to O and from P to Q. Below A stands the engraver's note "Autor Sculpsit." (the author engraved it).

- E (top), Cornu ♉: the upper horn of Taurus
- I, H, R, N, G (above the ecliptic, left to right): points on the ecliptic
- C (left end of the ecliptic): end of the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- F (right, just below the ecliptic), Cometa: the comet

[53] the right-hand column of the check calculation.

- M (right of centre), Palilic.: Palilicium [Aldebaran]
- O (right, at the end of the dotted line from M): point on a circle of latitude
- D (left), Humer. luc. Or.: the bright shoulder of Orion
- K (left of centre, at the end of the dotted line from D): point on a circle of latitude
- P (lower centre), Regel.: Rigel
- Q (lower right, at the end of the dotted line from P): point on a circle of latitude
- A (foot): the pole of the ecliptic, where the circles of latitude meet
- Autor Sculpsit. (right of A): the engraver's note

In the accompanying diagram, let A be the pole of the ecliptic; ♈ C the ecliptic; the circles rising from the pole to the ecliptic, circles of latitude; D the right shoulder of Orion; E the upper horn of Taurus, which has a northern latitude; and F the comet. First, then, from the complement of the latitude, A D, horn of Taurus, and the angle E A D, which is measured by H I, the difference of the longitudes of the stars (namely the horn of Taurus and Orion's right shoulder), you will compute the perpendicular D H and A K. Then take A K from A E, so as to have K E.[54]

2. In the triangle K E D, from the two known sides K D and K E, let E D be found, the distance between the fixed stars of Orion's right shoulder and the upper horn of Taurus, and likewise

[Margin: Calculi me- thodus.] [Method of the calculation.]

the angle K E D. 3. With all the sides of the larger triangle D E F given, the angle A E F is found as above. Once it is known, and the side E F is given, seek in turn the perpendicular F L and the side E L, so as to arrive at A L. And so, finally, in the right triangle A L F, given namely the two sides F L and L A, you will find the hypotenuse A F, the complement of the comet's latitude, and also the angle F A L, the difference of the longitudes of the comet and the horn of Taurus. If this difference is subtracted from the longitude of the horn of Taurus, you will have the comet's longitude sought itself.

Quantity	Value	Quantity	Value	Quantity	Value
Longitude of Orion's right shoulder	83° 56′ 12″	Latitude of Orion's shoulder, I D	16° 5′ 30″	Latitude of the horn of ♉, H E	5° 20′ 30″ *North*
Longitude of the upper horn of ♉	77° 43′ 42″	Compl. of the latitude, A D	73° 54′ 30″	Sum, 90° added	95° 20′ 30″ A E
Difference, angle H A I	6° 12′ 30″				

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[54] the page prints "A D Cornu ♉"; in the figure D is the shoulder of Orion and E the horn of Taurus, and the calculation overleaf takes A D as the complement of the shoulder's latitude. The perpendicular printed here as D H is labelled D K in that calculation, where D K is the dotted line in the figure.

[55] the three groups stand side by side across the page.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the compl. of the latitude	A D	4005			
Log. of the angle	H A I	222428	*A.*		
Log. of the perpendicular	D K	226433		5° 57′ 50″	
Antilog. of the hypotenuse	A D	128310			
Antilog. of the perpendicular	D K	542	*S.*		
Antilog.	K A	127768		73° 49′ 6″	
	A E			95° 20′ 30″	
	K E			21° 31′ 24″	
Antilog.	E K	7228			
Antilog. of the perpendicular	K D	542	*A.*		
Antilog.	E D	7770		22° 17′ 44″	*distance of Orion's shoulder and the horn of* ♉
Log. of the perpendicular	K D	226433			
Log.	E D	96920	*S.*		
Log. of the angle	D E K	129513		15° 53′ 40″	

Line	Value	Logarithm	Mark	Remark
Side E D	22° 17′ 44″	96920		
Side E F	20° 27′ 0″	105157	*A.*	
Difference	1° 50′ 44″	202077		*first aggregate*
Side D F	28° 22′ 0″			
Sum	30° 12′ 44″			
Half	15° 6′ 22″	134473		
Difference	26° 31′ 16″			
Half	13° 15′ 38″	147236	*A.*	
Second aggregate		281709		
First aggregate		202077		
Remainder		79632		

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Line	Arc	Logarithm	Mark	Value	Remark
Half		39816		42° 11′ 14″	*half-angle*
Whole angle	D E F			84° 22′ 28″	

[56] the left-hand column of the calculation, set as one column on the page; it is divided here where the triangle D E F begins. The remark on the distance stands on two lines, the second opened by a square bracket; each logarithm in the second part is preceded by "Log." on the page.

Line	Arc	Logarithm	Mark	Value	Remark
Angle	D E K			15° 53′ 40″	*S.*
Angle	A E F			68° 28′ 48″	
Log.	E F	105157			
Log.	A E F	7226	*A.*		
Log. of the perpendicular	F L	112383		18° 58′ 3″	
Antilog. of the hypotenuse	E F	6510			
Antilog. of the perpendicular	F L	5582	*S.*		
Antilog.	E L	928		7° 48′ 15″	
	A E			95° 20′ 30″	
	A L			87° 32′ 15″	
Antilog. of the perpendicular	F L	5582			
Antilog.	A L	314400	*A.*		
Antilog.	A F	319982		87° 39′ 40″	*compl. of the latitude*
Latitude sought	F G			2° 20′ 20″	*South*
Log.	F L	112383			
Log.	A F	83	*S.*		
Log.	F A L	112300		18° 59′ 2″	*or the side* N G
Longitude of the horn of ♉	♈ H			77° 43′ 42″	
The remainder is the longitude of the comet sought	♈ G			28° 44′ 40″ ♉	

[57]

[Margin: Examen calculi.] [Checking the calculation.]

On the same day, the 23rd, in the evening, at $9^h\ 53^m\ 30^s$, the distance between the comet and Palilicium was also taken with the sextant, as 6° 55′. By this distance we shall now test the comet's place just found: does the same distance also come out, given, that is, the longitude and latitude of the comet and of Aldebaran [Aldeboræ]? First, then, we shall find the perpendicular O M in the triangle F A M, from A M, the complement of Aldebaran's latitude, and the angle O A M, or G N, the difference of the longitudes of the comet and Palilicium; and likewise also A O, so that O F results when the subtraction is made from A F, the complement of the comet's latitude. Then from these two sides found, O M and O F, let the distance F M itself, between the comet and Palilicium, be sought in the triangle M O F, in the way described above.[58]

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the latitude of Palilicium	A M			84° 30′ 3″	
Compl. of the latitude of the comet	A F			87° 39′ 40″	
Longitude of the comet	♈ G			58° 44′ 20″	

[57] the right-hand column of the calculation.

[58] the page prints "trianguio" for "triangulo" in the last sentence.

Line	Arc	Logarithm	Mark	Value	Remark
Longitude of Palilicium	♈ N			64° 57′ 8″	
Difference, or angle	G A N			6° 12′ 48″	
Log.	A M	461			
Log.	G A N	222347	*A.*		
Log. of the perpendicular	M O	222808		6° 11′ 5″	

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Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	A M	234501			
Antilog. of the perpendicular	M O	583	*S.*		
Antilog.	A O	233918		84° 27′ 56″	
Compl. of the latitude of the comet	A F			87° 39′ 40″	
	F O			3° 11′ 44″	
Antilog.	F O	155			
Antilog. of the perpendicular	M O	583	*A.*		
Antilog.	F M	738		6° 57′ 15″	*distance of the comet and Palilicium sought*

60

The distance found, however, differs from the observed distance of the comet and Aldebaran by only 2′ 15″, which shows that the comet's place was determined accurately. We shall also try this by the distance of the comet and Regel observed on the same day, at $10^h\ 38^m$ in the evening, if by the same method the perpendicular P Q and the side F Q are found first, and then the distance itself of the comet and Regel is sought from the two sides P Q and F Q just found.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the latitude of Regel	A P			58° 49′ 20″	*South*
Compl. of the latitude of the comet	A F			87° 39′ 40″	*South*
Longitude of the comet	♈ G			58° 44′ 20″	
Longitude of Regel	♈ R			72° 1′ 12″	
Difference, or angle	G A R			13° 16′ 52″	
Log.	A P	15599			
Log.	G A R	147083	*A.*		
Log. of the perpendicular	P Q	162682		11° 20′ 8″	
Antilog.	A P				

[59] the left-hand column of the check calculation.

[60] the right-hand column of the check calculation; "A F" and "F O" stand in the logarithm column on the page, and the remark runs onto a second line below the figures.

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Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	A P	65837			
Antilog. of the perpendicular	P Q	1970	*S.*		
Antilog.	A Q	63867		58° 7′ 46″	
	F A			87° 39′ 40″	
	F Q			29° 31′ 54″	
Antilog.	F Q	13918			
Antilog. of the perpendicular	P Q	1970	*A.*		
Antilog.	P F	15888		31° 27′ 0″	*distance from Regel*
Observed distance of the comet and Regel				31° 38′ 0″	
Difference				11′ 0″	

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By this inquiry the difference between the observed and the computed distance does come out as 11′. But this arises from nothing other than the fact that this observation of the comet and Regel was made about 37^{m} after the distance of the comet and Orion's right shoulder, as the observation journal itself shows. Hence the distance derived from the calculation also necessarily had to be 11′ shorter. For in so long a space of time, namely 37^{m}, the comet, as the table of the comet's proper motion attests, advanced a full 11 minutes further upward. It is therefore certain that the comet's place was correctly observed and computed.

[Margin: Vnde differen- tia undecim minutorum ex- orta ſit?] [Where the difference of eleven minutes arose from.]

Observation 3. [Obſervatio 3.]

From the comet's alignment with two fixed stars in the foot of Perseus on one straight line, and from the distances, taken on December 26 at about 6^{h} in the evening, of the comet from the Heel [Calcaneus], 1° 45′, and of the Heel from the following star of Perseus's foot, let the comet's longitude and latitude be sought.

This observation, since it was noticed by many people at once, in the most diverse regions far apart from one another, certainly deserves that the comet's true place be carefully derived from it as well. We shall, however, reach the goal by a somewhat shorter route than was taken in the examples above, because the distances of the fixed stars and the comet did not at that time form a triangle among themselves but a straight line. Now in the following delineation the

[61] the left-hand column of the second check. The last line, "Antil. A P", stands by itself well to the right and lower down, level with the observed distance in the right-hand column, with no figure beside it.

[62] the right-hand column of the second check; "F A" and "F Q" stand in the logarithm column on the page. The remark on the computed distance is printed "dist." before the figures and "Regel." after them.

circles are named as before; F in turn is the comet, E the left heel, and D the following star of Perseus's left foot.

[Margin: Cometam cum duabus fixis in pede Perſei in lineâ rectâ conſtitutum fuiſſe, à plurimis obſervatum eſt.] [That the comet stood on a straight line with two fixed stars in the foot of Perseus was observed by very many.]

Diagram. An engraved figure in a ruled frame, set to the left of the prose. From A at the top three arcs, circles of latitude, descend to the ecliptic at the foot, meeting it at H, N and G from left to right; the sign of Aries stands at the right end of the ecliptic, beyond G. A star at D on the left arc, a star at E on the middle arc and a small circle at F on the right arc are joined by one straight line. L and K stand at the left of the left arc, with dotted lines running from L to F and from K to E. At the foot of the frame stands the engraver's note "Aut. Sculpſit." (the author engraved it).

- A (top): the point where the circles of latitude meet
- L, K (left of the left arc): points on the left arc, at the ends of the dotted lines from F and E
- D (left arc): a star
- E (middle arc), Calcan: the Heel
- Se[[g/q]]. in ped. Per (below D and E, with engraved tails to both): the following star in the foot of Perseus [?]
- F (right arc), Com.: the comet
- H, N, G (on the ecliptic, left to right): points on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- Aut. Sculpſit. (foot of the frame): the engraver's note[63]

1. From the difference of the longitudes of the Heel E and the other fixed star D, and from the complement of the latitude of the Heel, let the perpendicular E K and the side K D be found in the triangle A E D. 2. In the triangle E K D, given the sides E K and K D, let the distance of the fixed stars E and D be sought, and likewise the angle E D K. 3. In the larger triangle F D L, since the angle D is entirely equal to the angle E D K found before, there will be no need this time to seek it by a separate calculation (as we did in the examples above, in which the distances form a triangle). Instead you will at once compute the perpendicular F L and the side A L from that same angle F D L and the side F D, which is the sum of the distances F E, of the comet and the Heel, and E D, of the fixed stars. 4. In the triangle F L A you will find A F, the complement of the latitude, and the angle F A L, namely G H, the difference of the longitudes of the comet and the following star in the foot of Perseus. When this is subtracted from the longitude of the star just named, there remains ♈ G, the comet's longitude sought.

[63] the last letters of "Calcan" and of "Per" are crossed by the right-hand arc; the second letter of the abbreviation below D and E has a looped descender and is not clearly g or q.

Quantity	Value	Quantity	Value	Quantity	Value
Long. of the following star of Perseus's left foot	58° 20′ 12″ ♈ H	Latitude of the following star, D H	11° 18′	Latitude of the Heel	12° 8′ E N
Long. of the star in the left Heel	56° 17′ 12″ ♈ N	Compl. of the latitude, A D	78° 42′	Compl. of the lat.	77° 52′ E A
Angle E A D	2° 3′ 0″				

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Line	Arc	Logarithm	Mark	Value	Remark
Log. of the compl. of the lat.	E A	2259			
Log.	E A D	333060	*A.*		
Log. of the perpendicular	E K	335319		2° 0′ 15″	
Antilog. of the compl. of the lat.	E A	155975			
Antilog. of the perpendicular	E K	61	*S.*		
Antilog.	A K	155914		77° 51′ 32″	
Compl. of the latitude of the following star	A D			78° 42′ 0″	
	K D			50′ 28″	
Antilog.	K D	11			
Antilog. of the perpendicular	E K	61	*A.*		
Antilog. of the distance	E D	72		2° 10′ 0″	*distance of the stars, of the Heel from the following star*
Log. of the perpendicular	E K	335319			
Log.	E D	327527	*S.*		
Long. [recte: Log.] of the angle	E D K	7792		67° 40′ 25″	
Distance	E D **			2° 10′	
Distance	E F			1° 45′	
Distance	F D			3° 55′	

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Line	Arc	Logarithm	Mark	Value	Remark
Log. of the distance	F D	268376			
Log. of the angle	E D K	7792	*A*		
Log. of the perpendicular	F L	276168		3° 37′ 22″	
Antilog.	F D	234			

[64] the three groups stand side by side across the page.

[65] the left-hand column of the calculation. "K D" stands in the logarithm column on the page. The remark on the distance of the stars stands on two lines, the second opened by a printed square bracket; the figures 2° 10′ 0″ are set inside the remark's first line. The two asterisks after E D are printed star marks.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	F L	200	*S.*		
Antilog.	L D	34		1° 30′ 0″	
Compl. of the latitude of the following star	A D			78° 42′ 0″	
	A L			77° 12′ 0″	
Antilog. of the perpendicular	F L	200			
Antilog.	A L	150711	*A.*		
Antilog.	A F	150911		77° 13′ 34″	*compl. of the lat.*
Latitude of the comet sought	F G			12° 46′ 26″	
Log. of the perpendicular	F L	276168			
Log.	A F	2506	*S.*		
Log.	F A L	273662		3° 42′ 43″	
Longitude of the following star in the foot of Perseus	♈ H			58° 20′ 12″	
Longitude of the comet sought	♈ G			24° 37′ 29″ ♉	

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Although this time, for want of observations, we cannot check this place of the comet, the observations that follow nonetheless show amply that the inquiry into the comet's place was carried out correctly.

Observation 4. [Obfervatio 4.]

Given the comet's distances from Palilicium, 21° 32′, and from the upper horn of Taurus, 24° 11′, taken on December 26 at 9^h 0^m 34^s, let its longitude and latitude be sought.

In the adjoining figure [iconismo], let A be the north pole of the ecliptic and ♈ H the ecliptic; the circles descending from the pole to the ecliptic are circles of latitude; F is the comet, M Palilicium, E the upper horn of Taurus, S Capella, and P the Bright Star of Aries. Therefore, once the difference of the longitudes of Palilicium and the horn of Taurus is known, namely N H, the angle M A E, together with the complement of the latitude of the horn of Taurus, there result in the triangle M A E the perpendicular E L and the side L M. 2. In the triangle E L M, from E L and L M, let the distance of Palilicium and the horn of Taurus, M E, be computed, and at the same time the angle L M E. 3. With all three sides of the triangle M F E given, let the angle E M F be sought; if the angle L M E is subtracted from it, the angle A M F will remain. 4. By the distance of the comet and Aldebaran, F M, and the angle A M F just found, let the perpendicular F K and the side M K be found in turn, so that A K results. 5. And finally, from F K and A K, in the triangle F A K, you will compute A F, the complement of the comet's latitude, and the angle F A K, the difference of the longitudes of the comet and Palilicium, namely G N. If you subtract this difference from the longitude of Palilicium, ♈ N, there remains ♈ G, the true longitude of the comet sought.

[66] the right-hand column of the calculation; "A L" stands in the logarithm column on the page.

Diagram. An engraved figure in a ruled frame, set to the right of the prose. From A at the top, arcs descend to the ecliptic, which runs across the foot; on it stand H and V at the left, G in the centre and R at the right, with the sign of Aries at its right end. The stars are drawn as asterisks: S, labelled "Capella.", at the left; E, labelled "Cornu ♉.", lower left; P, labelled "Lucid. ♈.", at the right; and M, labelled "Palilicium.", below the ecliptic. The comet is a small circle at F, labelled "Cometa", in the centre. Straight lines join F to S, E, P and M, and E to M; dotted lines run from S to T, from K to F, from E to L and from P to Q. At the foot, right, stands the engraver's note "Autor Sculpſit." (the author engraved it).

- A (top): the north pole of the ecliptic
- S, Capella.: Capella
- T (right of S, at the end of the dotted line): a point on a circle of latitude
- K (left of F, at the end of the dotted line): a point on a circle of latitude
- F, Cometa: the comet
- P, Lucid. ♈.: the Bright Star of Aries
- Q (below F, at the end of the dotted line from P): a point on a circle of latitude
- E, Cornu ♉.: the upper horn of Taurus
- L (at the end of the dotted line from E): the foot of the perpendicular E L
- H, V, G, R (on the ecliptic): points on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- M (below the ecliptic), Palilicium.: Palilicium
- Autor Sculpſit. (foot, right): the engraver's note[67]

Quantity	Value	Quantity	Value	Quantity	Value
Long. of the upper horn of ♉	77° 43′ 42″	Latit. of the horn, E H	5° 20′ 30″ *North*	Latit. of Aldebaran, N M	5° 29′ 57″
Long. of Aldebaran, ♈ N	64° 57′ 8″	Compl. of the latit., A E	84° 39′ 30″	Distance from the pole, A M	95° 29′ 57″
Difference, or angle H A N	12° 46′ 34″				

[68]

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the compl. of the lat. of the horn	A E	436			
Log. of the angle	H A N	150897	*Ad.*		
Log. of the perpendicular	E L	151333		12° 43′ 24″	
Antilog. of the compl. of the lat.	A E	237414			

[67]the text names a point N on the ecliptic (N H, G N, ♈ N); no N is engraved on the figure.
[68]the three groups stand side by side across the page.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog. of the perpendicular	E L	2486	*S.*		
Antilog.	A L	234928		84° 31′ 24″	
	A M			95° 29′ 57″	
	L M			10° 58′ 33″	
Antilog.	L M	1846			
Antilog. of the perpendicular	E L	2486	*A.*		
Antilog. of the distance	E M	4332		16° 45′ 20″	*of Aldebaran and the horn of Taurus*

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Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the perpendicular	E L	151333			
Log. of the distance	E M	124379	*S.*		
Log. of the angle	L M E	26954		49° 47′ 40″	
Side	E M	124379		16° 45′ 20″	
Side	F M	100228	*A.*	21° 32′ 0″	
Difference		224607		4° 46′ 40″	*first aggregate*
Side	F E			24° 11′ 0″	*distance of the comet and the horn*
Sum				28° 57′ 40″	
Half		138608		14° 28′ 50″	
Difference				19° 24′ 20″	
Half		178060	*A.*	9° 42′ 10″	
Second aggregate		316668			
First aggregate		224607	*S.*		
Log. Remainder		92061			

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Line	Arc	Logarithm	Mark	Value	Remark
Half		46030		39° 7′ 50″	
Whole angle	E M F			78° 15′ 40″	
Angle	L M E			49° 47′ 40″	*S.*
Angle	A M F			28° 28′ 0″	
Log.	F M	100228			
Log.	A M F	74098	*A.*		
Log. of the perpendicular	F K	174326		10° 4′ 33″	
Antilog. of the hypotenuse	F M	7235			
Antilog. of the perpendicular	F K	1554	*S.*		

[69] the left-hand column of the calculation. The remark on the distance stands on two lines, the figures set inside its first line and the second opened by a printed square bracket.

[70] the right-hand column of the calculation. On the page the logarithms of the sides and halves stand in a column to the right of the degrees, each preceded by "Log."; the "Log." of the last line stands well to the left of "Residuum".

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	K M	5681		19° 7′ 6″	
	A M			95° 29′ 57″	
	A K			76° 22′ 51″	

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Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog. of the perpendicular	F K	1554			
Antilog.	A K	144618	*A.*		
Antilog.	A F	146172		76° 35′ 42″	*compl. of the lat.*
Latitude of the comet sought, North				13° 24′ 18″	F G
Log. of the perpendicular	F K	174326			
Log.	A F, *compl. of the lat.*	2763	*S.*		
Log.	F A K	171564		10° 21′ 38″	G N
Longitude of Aldebaran	♈ N			64° 57′ 8″	
Longitude of the comet sought	♈ G			24° 35′ 30″ ♉	

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The check is made from the distance of the comet and the Bright Star of Aries, 21° 29′, observed on the same day at 9^{h} 14^{m} 56^{s}: namely by finding, in the triangle P A Q, from A P, the complement of the latitude of the Bright Star of Aries, and the angle P A Q, the difference of the longitudes of the comet F and the Bright Star of Aries, the perpendicular P Q and F Q; and so, in the triangle F P Q, from Q F and P Q, the distance itself of the comet and the Bright Star of Aries, sought by calculation.

[Margin: Examen ini- tum per di- ſtantiam Co- metæ à luci- da Arietis.] [The check made by the distance of the comet from the Bright Star of Aries.]

Line	Arc	Loga-rithm	Mark	Value	Re-mark
Compl. of the latitude of the Bright Star of ♈	A P			80° 2′ 30″	
Compl. of the latitude of the comet	A F			76° 35′ 42″	
Longitude of the comet	♈ G			54° 35′ 30″	
Longitude of the Bright Star of ♈	♈ R			32° 49′ 57″	
Angle	P A Q			21° 45′ 53″	
Log.	A P	1518			
Log. of the angle	P A Q	99211	*A.*		

[71] the left-hand column of the calculation; "A M" and "A K" stand in the logarithm column on the page.

[72] the right-hand column of the calculation. A small raised point stands within the logarithm of F A K, after its third figure.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the perpendicular	P Q	100729		21° 25′ 13″	

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Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	A P	175487			
Antilog. of the perpendicular	P Q	7157	*S.*		
Antilog.	A Q	168330		79° 18′ 19″	
Compl. of the latitude of the comet	A F			76° 35′ 42″	
	F Q			2° 42′ 37″	
Antilog.	Q F	112			
Antilog. of the perpendicular	P Q	7157	*A.*		
Antilog.	P F	7269		21° 34′ 55″	*distance of the comet and the star*
The observed distance was				21° 29′ 0″	
Difference between the two distances				5′ 55″	

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That the distance found is 5′ 55″ greater than the observed one comes from the fact that the distance of the Bright Star of Aries was not taken at the very moment when Aldebaran or the upper horn of Taurus was observed, but was noted about 30^{m} later. And so, since the comet's proper motion in that time, as its table shows, was 10′, the distance found must necessarily also be 5′ greater than the observed one. But if all three observations of the distances could have been made together, they would surely have agreed to the very minute. On this day, therefore, the comet's place was determined best of all.

But for the sake of greater certainty let us submit the comet's place to yet another check, and compute in the usual way, from its true place, the distance of Capella and the comet, since that distance was likewise observed at about that time, namely at $11^{h}\ 20^{m}\ 25^{s}$. In the earlier figure [Schemate], then, and in the triangle F A S, there are given the complement of the latitude of Capella, A S, with the angle F A S, the difference of the longitudes of the comet and Capella, so that the perpendicular S T and the side F T result; and from these two given sides, in the triangle S T F, F S, the distance of Capella and the comet sought, is derived.

[Margin: Examen ini- tum per dist. Cometæ à Ca- pellâ.] [The check made by the distance of the comet from Capella.]

[73] the left-hand column of the check. The fourth line is printed "Longit. lucid. ♈, R ♈", the sign standing both before and after R.

[74] the right-hand column of the check; "A F" and "F Q" stand in the logarithm column on the page. The remark on the computed distance is printed "Dist." before the figures and "Com. & *" after them.

Line	Arc	Logarithm	Mark	Value	Re-mark
Compl. of the latit. of Capella	S V			67° 7′ 45″	
Compl. of the latit. of the comet	A F			76° 35′ 42″	
Long. of the comet	♈ G			54° 35′ 30″	
Long. of Capella	♈ V			77° 0′ 12″	
Angle	F A S			22° 24′ 42″	
Log. of the compl. of the lat. of Capella	A S	8188			
Log. of the angle	F A S	96427	*A.*		
Log. of the perpendicular	S T	104615		20° 33′ 58″	

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Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	A S	94577			
Antilog. of the perpendicular	S T	6586	*S,*		
Antilog.	A T	87991		65° 29′ 30″	
Compl. of the latit. of the comet	A F			76° 35′ 42″	
	T F			11° 6′ 12″	
Antilog.	T F	1889			
Antilog. of the perpendicular	S T	6586	*A.*		
Antilog. of the distance		8475		23° 16′ 0″	*of Capella*, F S
The observed distance				23° 22′ 0″	
Difference				6′ 0″	

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The observed distance is indeed 6′ greater than the one found. The reason is that the distance of the horn and the comet was noted about 28^{m} later, and so the distances cannot agree to the very minute.

Observation 5. [Obſervatio 5.]

Given the comet's distances from the upper horn of Taurus, 24° 35′, and from Capella, 23° 22′, taken on December 26 at about 11^{h} 48^{m}, let the comet's longitude and latitude be sought.

First, since in this figure F is the comet, S Capella and E the horn of Taurus, let the perpendicular S T and the side T E be found in the triangle E S A. 2. Also the distance itself of the fixed stars Capella and the horn of Taurus, S E, together with the angle S E T, from the perpendicular S T found before and the side T E. 3. With the three sides thus known, the angle F E S is found in the triangle F S E; if the angle S E T is added to it, the angle F E A results. 4. In the triangle F E A, in turn, let the perpendicular F K and the side A K be computed, so that in the triangle F K A, from F K and A K, there result the

[75] the left-hand column of the check. The first line is printed with "S V", where the text of the preceding page names the side A S.

[76] the right-hand column of the check; "A F" and "T F" stand in the logarithm column on the page. The computed distance is printed with "Capell." before the figures and "F S" after them.

complement of the comet's latitude, A F, and also the angle F A K, or G H, the difference of the longitudes of the comet and the horn of Taurus. When this difference is subtracted from the longitude ♈ H, there will remain ♈ G, the longitude of the comet sought.

Diagram. An engraved figure in a ruled frame, set to the right of the prose. From A at the top four arcs, circles of latitude, descend to the ecliptic, which runs across the foot; they meet it at H, N, I and G from left to right, and the sign of Aries stands at the right end of the ecliptic, beyond G. The stars are drawn as asterisks: S, labelled "Capella.", upper left; E, labelled "Cornu ♉", lower left; and B, labelled "Plaiad. antec.", lower right. The comet is a small circle at F, labelled "Com.", at the right. T, K and E lie on the leftmost arc and S on the second; C stands beside the third arc, near F. Straight lines join S to E and to F, E to F, and F to B; dotted lines run from T to S and from K towards F. At the foot, right, stands the engraver's note "Autor Sculpſit." (the author engraved it).

- A (top): the north pole of the ecliptic
- T (left, on the leftmost arc, at the end of the dotted line from S): the foot of the perpendicular S T
- S, Capella.: Capella
- K (left, on the leftmost arc, at the end of the dotted line to F): the foot of the perpendicular F K
- F, Com.: the comet
- C (beside the third arc, near F): a point, not named in the text of this page
- E, Cornu ♉: the horn of Taurus
- B, Plaiad. antec.: the leading star of the Pleiades
- H, N, I, G (on the ecliptic): points on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- Autor Sculpſit. (foot, right): the engraver's note

Quantity	Value	Quantity	Value	Quantity	Value
Long. of the upper horn of ♉, ♈ H	77° 43′ 42″	Latit. of the horn of ♉, E H	5° 20′ 30″	Lat. of Capella, S N	22° 52′ 15″
Long. of Capella, ♈ N	77° 0′ 12″	Compl. of its latit., E A	84° 39′ 30″	Compl. of the latit., A S	67° 7′ 45″
Diff., N H or N A H	43′ 30″				

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Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the compl. of the lat. of Capella		8189			

[77] the three groups stand side by side across the page. The difference is printed under the minutes and seconds only.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the angle	H A N	436991	*A.*		
Log. of the perpendicular	S T	445180		0° 40′ 5″	
Antilog. of the compl. of the lat. of Capella		94509			
Antilog. of the perpendicular	S T	7	*S.*		
Antilog.	A T	94502		67° 7′ 39″	
Compl. of the lat. of the horn	A E			84° 39′ 30″	
	T E			17° 31′ 51″	
Antilog.	T E	4756			
Antilog. of the perpendicular	S T	7	*A.*		
Antilog. of the distance	S E	4763		17° 32′ 40″	*of the horn and Capella*
Log. of the perpendicular	S T	445180			
Log.	S E	119918	*S.*		
Log. of the angle	S E T	325262		2° 13′ 1″	
Side	E S	119918		17° 32′ 40″	
Side	F E	87703	*A.*	24° 35′ 0″	
Difference		207621		7° 2′ 20″	*first aggregate*
Side	F S			23° 22′ 0″	
Sum				30° 24′ 20″	
Half		133851		15° 12′ 10″	
Difference				16° 19′ 40″	
Half		195188		8° 9′ 50″	
Second aggregate		329039			
First aggregate		207621	*S.*		
Remainder		121418			

78

Line	Arc	Logarithm	Mark	Value	Remark
Half		60709		33° 1′ 13″	*half-angle*
Whole angle				66° 2′ 26″	
Angle	S E T			2° 13′ 1″	*A.*
Angle	F E A			68° 15′ 27″	
Log.	F E	87703			
Log. of the angle		7380	*A.*		
Log. of the perpendicular	F K	95083		22° 43′ 53″	
Antilog.	F E	9502			

[78] the left-hand column of the calculation. The remark on the distance stands on two lines, "Cornu" after the figures and "& Capell." on the next line, opened by a printed square bracket. In the lines for the sides and halves the logarithms stand in a column to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Aggr. … prius". At the foot of the column stands "Semis-", the first word of the right-hand column.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog. of the perpendicular	F K	8086	*S.*		
Antilog.	K E	1416		9° 37′ 12″	
Compl. of the lat. of the horn	A E			84° 39′ 30″	
	A K			75° 2′ 18″	
Antilog.	F K	8086			
Antilog.	A K	135412	*A.*		
Antilog.	A F	143498		76° 13′ 22″	*compl. of the lat. of the comet*
Latitude of the comet sought, North	F G			13° 46′ 38″	
Log. of the perpendicular	F K	95083			
Log.	A F	2919	*S.*		
Log.	F A K	92164		23° 26′ 42″	*S.*
Longitude of the horn of ♉	♈ H			77° 43′ 42″	
Longitude of the comet sought	♈ G			24° 17′ 0″ ♉	

79

Now, examining this place of the comet against the leading star of the Pleiades (whose distance from the comet was found at about that time to be 9° 57′), let the perpendicular F C and the side C B be sought in the triangle B F A of the preceding figure itself. Then, with the two sides F C and C B thus found, the distance sought, B F, of the leading star of the Pleiades and the comet, is known in the triangle F C B.

[Margin: Examen calculi.] [The check of the calculation.]

Line	Arc	Logarithm	Mark	Value	Re-mark
Compl. of the lat. of the star	A B			86° 4′ 30″	
Compl. of the lat. of the comet	A F			76° 13′ 22″	
Long. of the comet	♈ G			54° 17′ 0″	
Long. of the leading star of the Pleiades	♈ I			55° 31′ 12″	
Angle, the difference	G A I			1° 14′ 12″	
Log.	A F	2919			
Log. of the angle	G A I	383589	*A.*		
Log. of the perpendicular	F C	386508		1° 12′ 4″	

80

[79] the right-hand column of the calculation. The remark on the half is printed "ſemi-" on the first line and "angul." on the second, opened by a printed square bracket. The arc of the second logarithm line is not printed. The remark on A F is printed "Cõpl." before the figures and "lat. Com." after them; the latitude is printed with "Bor." after the figures.

[80] the left-hand column of the check. The star is printed as an asterisk in the first line. The arc ♈ I of the fourth line is printed after the figures. The seconds of the first line carry no sign on the page.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	A F	143498			
Antilog. of the perpendicular	F C	22	*S.*		
Antilog.	A C	143476		76° 13′ 17″	
Compl. of the lat. of the star of the Pleiades	A B			86° 4′ 30″	
	C B			9° 51′ 13″	
Antilog.	C B	1486			
Antilog.	F C	22	*A.*		
Antilog.	F B	1508		9° 55′ 36″	*distance of the comet and the star*
The observed distance				9° 57′ 0″	
Difference				1′ 24″	

81

Since, therefore, the difference of the distances is only 1′ 24″, it is plain to anyone that there has been no error at all in this place of the comet.

Observation 6. [Obfervatio 6.]

Given the comet's distances from Palilicium, 22° 5′, and from the upper horn of Taurus, 24° 36′, taken on December 27 at 2^h 6^m in the morning, let the comet's longitude and latitude be sought.

Since on page 43 we likewise investigated the comet's position from the distances of Palilicium and the horn of Taurus from the comet, the distance of Palilicium and the horn of Taurus, together with the angle L M E, is already known to us from that very calculation of the fourth observation. Therefore, with all the sides of the triangle F M E thus known, in the adjoining figure [iconismo] (in which F is the comet, M Palilicium, E the horn of Taurus and S Capella), let E M F now be sought; from it let the angle L M E be subtracted, so that the angle A M F becomes evident. By this angle, once found, and the side F M, namely the distance of the comet and Palilicium, let the search be made; then both F K and A K, in the triangle A F M. From these sides there will finally result A F, the complement of the comet's latitude A F, and likewise the angle F A K, or G N, the difference of the longitudes of the comet and Palilicium. When this is subtracted from the longitude of Palilicium, ♈ N, there remains the longitude of the comet sought, ♈ G.

Diagram. An engraved figure in a ruled frame, set to the right of the prose. From A at the top arcs, circles of latitude, descend to the ecliptic, which runs across the foot; on it stand H and V at the left and G at the right, with the sign of Aries at its right end. The stars are drawn as asterisks: S, labelled "Capella.", at the upper left; E, labelled "Cornu ☋.", at the lower left; and M, labelled "Palilicium.", below the ecliptic. The comet is a small circle at F, labelled

[81] the right-hand column of the check; "C B" stands in the arc column on the page. The computed distance is printed "dist." before the figures and "Com. & *" after them; the star is printed as an asterisk.

”Comet.”, at the right. Straight lines join F to S, E and M, and E to M; dotted lines run from S to T, from K to F and from E to L. At the foot, right, stands the engraver's note ”Aut. Sculpſ.” (the author engraved it).

- A (top): the north pole of the ecliptic
- S, Capella.: Capella
- T (right, at the end of the dotted line from S): a point on a circle of latitude
- K (centre, at the end of the dotted line from F): a point on a circle of latitude
- F, Comet.: the comet
- E, Cornu ♉.: the horn of Taurus
- L (at the end of the dotted line from E): the foot of the perpendicular from E
- ♈ (right end of the ecliptic): the sign of Aries
- G, H, V (on the ecliptic): points on the ecliptic
- M (below the ecliptic), Palilicium.: Palilicium
- Aut. Sculpſ. (foot, right): the engraver's note[82]

Line	Arc	Logarithm	Mark	Value	Remark
Side	E M	124379		16° 45′ 20″	
Side	F M	97829		22° 5′ 0″	
Difference		222208		5° 19′ 40″	*first aggregate*
Side	F E			24° 36′ 0″	
Sum				29° 55′ 40″	
Half		135399		14° 57′ 50″	
Difference				19° 16′ 20″	
Half		178742	*A.*	9° 38′ 10″	
Second aggregate		314141			
First aggregate		222208	*S.*		
Remainder		91933			
Half		45966		39° 9′ 38″	
Whole angle	E M F			78° 19′ 16″	
Angle	L M E			49° 47′ 40″	*S.*
Angle	A M F			28° 31′ 36″	

[83]

Line	Arc	Loga-rithm	Mark	Value	Remark
Log.	F M	97829			
Log.	A M F	73905	*A.*		

[82]the text names a point N on the ecliptic (G N, ♈ N); no N is engraved on the figure.

[83]the left-hand column of the calculation. In the lines for the sides and halves the logarithms stand in a column to the right of the degrees, each preceded by ”Log.”; the first aggregate is printed ”Agg. … prius”. The logarithm of the last half stands to the right of its degrees.

Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the perpendicular	F K	171734		10° 20′ 35″	
Antilog.	F M	7619			
Antilog. of the perpendicular	F K	1638	*S.*		
Antilog.	K M	5981		19° 37′ 11″	
Distance of Palilicium from the pole	A M			95° 29′ 57″	*S.*
	A K			75° 52′ 46″	
Antilog. of the perpendicular	F K	1638			
Antilog.	A K	141072	*A.*		
Antilog.	A F	142710		76° 6′ 46″	*compl. of the lat. of the comet*
Latitude of the comet sought, North				13° 53′ 14″	
Log. of the perpendicular	F K	171734			
Log.	A F	2967	*S.*		
Log. of the angle	F A K	168767		10° 39′ 29″	*To be subtracted*
Longitude of Palilicium	♈ N			64° 57′ 8″	
Longitude of the comet sought	♈ G			24° 17′ 39″ ♉	

[84]

While we make the check by the distance of the comet and Capella, which was found at almost the same time, namely at $1^h\ 40^m$, to be 23° 23′, there is found in the same figure, first, in the triangle A S T, the perpendicular S T, from the complement of the latitude of Capella, A S, and from the difference of the longitudes of Capella and the comet,

[Margin: Examen calculi.] [The check of the calculation.]

namely the angle F A S; and at the same time, from the perpendicular S T so found and the same angle F A S, the side T F; and so finally, in the triangle F T S, by the perpendicular S T and the side T F, the distance itself of the comet and Capella, F S.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of Capella	S A			67° 7′ 45″	
Compl. of the lat. of the comet	A F			76° 6′ 46″	
Long. of the comet	♈ G			54° 17′ 39″	
Long. of Capella	♈ V			77° 0′ 12″	
Diff., or angle	T A S			22° 42′ 33″	
Logarithm	S A	8188			
Log. of the angle	T A S	95176	*A.*		
Log. of the perpendicular	S T	103364		20° 50′ 13″	

[84] the right-hand column of the calculation; "A K" stands in the arc column on the page. The remark on A F is printed "Cõpl." before the figures and "lat. Com." after them; "Subtrah." stands after the angle F A K.

85

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	S A	94509			
Antilog. of the perpendicular	S T	6764	*S.*		
Antilog.	A T	87745		65° 25′ 38″	
Compl. of the latit. of the comet	A F			76° 6′ 46″	
	T F			10° 41′ 8″	
Antilog.	T F	1749			
Antilog. of the perpendicular	S T	6764	*A.*		
Antilog. of the distance		8513		23° 18′ 30″	*of the comet and Capella*
Observed distance of the comet and Capella				23° 23′ 0″	
Difference				4′ 30″	

86

And from this small difference, since it is scarcely as great as the hourly motion of 30 minutes [?], as the comet's table shows, it is abundantly clear that everything has been determined most correctly.

Observation 7. [Obſervatio 7.]

Given the comet's distances from Palilicium, 24° 16′ 30″, and also from Capella, 22° 48′, taken on December 27 in the evening at about 5^h 38^m 10^s, let the comet's longitude and latitude be sought.

In the present diagram let F be the comet, M Aldebaran, S Capella, and P the Bright Star of Aries. Here the first thing to be sought is the distance of Capella and Palilicium, together with the angle V M S. Therefore, as was done in the earlier examples, we shall compute the perpendicular S V in the triangle A S M, from the complement of the latitude of Capella, A S, and the angle S A M, namely the difference of longitude N H; and then also A V, so that V M results. 2. In the right-angled triangle M V S, with the two sides V S and V M given, which contain the right angle, the distance itself of the fixed stars, S M, is known, and also the angle V M S, once the hypotenuse S M and the side V S are known. 3. From the three sides of the oblique-angled triangle S M F let the angle F M S be sought; if V M S is taken from it, the remainder will be the angle A M F. Then from this angle and the distance of the comet and Aldebaran, F M, let the perpendicular F K and A K be found in the triangle F M A in the usual way. 4. In the right-angled triangle F A K, with the two sides F K and A K thus just found, let A F, the complement of the comet's latitude, be sought, and the angle F A K, or the difference of the longitudes of the comet and Aldebaran; if you take this from the longitude of Palilicium, ♈ N, you will have the longitude of the comet sought, ♈ G.

[85] the left-hand column of the check.

[86] the right-hand column of the check; "T F" stands in the arc column on the page. The computed distance is printed with "Com." before the figures and "& Capel." after them.

Quantity	Value	Quantity	Value	Quantity	Value
Long. of Palilicium, ♈ N	64° 57′ 8″	Latit. of Capella, H S	22° 52′ 15″	Lat. of Palilicium, N M, *South*	5° 29′ 57″
Long. of Capella, ♈ H	77° 0′ 12″	Compl. of the latit., S A	67° 7′ 45″	Distance from the pole, A M	95° 29′ 57″
Diff., or angle M A S	12° 3′ 4″				

87

Line	Arc	Loga-rithm	Mark	Value	Remark
Log. of the compl. of the lat. of Capella	A S	8188			
Log. of the angle	H A N	156645	*A.*		
Log. of the perpendicular	S V	164834		11° 5′ 27″	
Antilog. of the compl. of the lat.	A S	94509			
Antilog. of the perpendicular	S V	1885	*S.*		
Antilog.	A V	92614		66° 40′ 0″	
Distance of Palilicium from the pole	A M			95° 29′ 57″	
	V M			28° 49′ 57″	
Antilog.	V M	13236			
Antilog. of the perpendicular	S V	1885	*A.*		
Antilog. of the distance	M S	15121		30° 43′ 13″	*of Capella and Palilicium*
Log. of the perpendicular	S V	164834			
Log. of the distance	M S	67169	*S.*		
Log. of the angle	V M S	97665		22° 7′ 17″	
Side	S M	67169		30° 43′ 13″	
Side	F M	88887	*A.*	24° 16′ 30″	
Difference		156056		6° 26′ 43″	*first aggregate*
Side	F S			22° 48′ 0″	
Sum				29° 14′ 43″	
Half		137653		14° 37′ 21″	
Difference				16° 21′ 17″	
Half		195036	*A.*	8° 10′ 38″	
Second aggregate		332689			
First aggregate		156056	*S.*		
Remainder		176633			

88

[87] the three groups stand side by side across the page.

[88] the left-hand column of the calculation. In the lines for the sides and halves the logarithms stand in a column to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Aggr. … prius". The distance M S is printed with "Capel." before the figures and "& Pal." after them.

Line	Arc	Loga-rithm	Mark	Value	Remark
Half		88816		24° 17′ 36″	*half-angle*
Whole angle	S M F			48° 35′ 12″	
Angle	V M S			22° 7′ 17″	*S.*
Angle	F M A			26° 27′ 55″	
Log.	F M	88887			
Log.	F M A	80819	*A.*		
Log. of the perpendicular	F K	169706		10° 33′ 27″	
Antilog. of the hypotenuse	F M	9257			
Antilog. of the perpendicular	F K	1707	*S.*		
Antilog.	K M	7550		21° 59′ 6″	
Distance of Palilicium from the pole	A M			95° 29′ 57″	
	A K			73° 30′ 51″	
Antilog. of the perpendicular	F K	1707			
Antilog.	A K	125955	*A.*		
Antilog.	A F	127662		73° 48′ 4″	*compl. of the lat. of the comet*
Latitude of the comet sought	F G			16° 11′ 56″	
Log. of the perpendicular	F K	169706			
Log.	A F	4052	*S.*		
Log.	F A K	165654		10° 59′ 58″	*or G N*
Longitude of Palilicium	♈ N			64° 57′ 8″	
Longitude of the comet sought	♈ G			23° 58′ 10″ ♉	

89

We shall test this place of the comet by the distance of the Bright Star of Aries and the comet, which was observed at the same time, in the evening at 5^{h} 46^{m} 27^{s}, as 21° 27′ 30″. In the triangle P A F of this figure, therefore, let the perpendicular P Q, falling outside the triangle, be sought from the complement of the latitude of the Bright Star of Aries, A P, and from the difference of the longitudes of the comet and the Bright Star of Aries, namely the angle P A F; and likewise the side Q F, from the side A P and P Q. And so finally, in the triangle P F Q, with P Q and F Q given, the distance sought of the comet and the Bright Star of Aries, P F, is found.

Diagram. An engraved figure set to the right of the prose, with no frame visible on the scan. From A at the top arcs, circles of latitude, descend to the ecliptic, which runs across the foot; on it stand H, N, G and R from left to right, with the sign of Aries at its right end, beyond R. The stars are drawn

[89] the right-hand column of the calculation; "A K" stands in the arc column on the page. The remark "semi- / angul." is set over two lines, the second opened by a printed square bracket. The remark on A F is printed "Cõpl." before the figures and "lat.Com." after them; "ſive" stands between the logarithm of F A K and its degrees, and "GN" after them.

as asterisks: S, labelled "Capella.", at the upper left; P, labelled "Lucid.♈." (the Bright Star of Aries), at the right, on the arc that meets the ecliptic at R; and M, labelled "Palilicium.", below the ecliptic at the lower left. The comet is a small circle at F, labelled "Cometa.", near the centre. Straight lines join S to F, F to P, S down to M, and F down to M; dotted lines run from S to V, from K to F, and from P leftward to a cursive letter standing below F. At the foot, right, stands the engraver's note "Autor Sculpf." (the author engraved it).

- A (top): the north pole of the ecliptic
- S, Capella. (upper left): Capella
- V (at the end of the dotted line from S): a point on a circle of latitude
- K (centre left, at the end of the dotted line from F): a point on a circle of latitude
- F, Cometa. (centre): the comet
- [?] (below F, at the end of the dotted line from P): a single engraved cursive capital, not settled on the scan
- P, Lucid.♈. (right): the Bright Star of Aries
- H, N, G, R (on the ecliptic, left to right): points on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- M, Palilicium. (below the ecliptic, lower left): Palilicium
- Autor Sculpf. (foot, right): the engraver's note[90]

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the latit. of the Bright Star of ♈	A P			80° 2′ 30″	
Compl. of the lat. of the comet	A F			73° 48′ 4″	
Long. of the comet	♈ G			53° 58′ 10″	
Long. of the Bright Star of Aries	♈ R			32° 49′ 57″	
Diff., angle	P A F			21° 8′ 13″	
Log.	A P	1518			
Log. of the angle	P A F	101998	*A.*		
Log. of the perpendicular	P Q	103516		20° 48′ 14″	

[91]

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	A P	175487			
Antilog.	P Q	6742	*S.*		
Antilog.	A Q	168745		79° 20′ 22″	
Compl. of the latit. of the horn	A F			73° 48′ 4″	
	F Q			5° 32′ 18″	

[90] the text names a point Q, the foot of the perpendicular from P; the only letter engraved at the end of the dotted line from P is the cursive capital listed above, whose form is not settled on this copy.

[91] the left-hand column of the check.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	Q F	468			
Antilog. of the perpendicular	P Q	6742	*A.*		
Antilog.	P F	7210		21° 29′ 49″	*distance of the comet and the star*
Observed distance				21° 27′ 30″	
Difference				2′ 19″	

92

Therefore the distance found differs from the observed one by no more than 2′ 19″, a difference that is surely of no importance.

Observation 8. [Obfervatio 8.]

Given the comet's distances from Palilicium, 25° 23′, and from the horn of Taurus, 26° 34′, taken on December 28 in the morning at 1^{h} 34^{m} 10^{s}, let its longitude and latitude be sought.

The distances of these fixed stars, namely Palilicium and the horn of Taurus, and also the angle L M E, are already known from the calculation of the fourth observation on pages 43 and 44; so there is no need to repeat the same calculation here again. Instead, the angle E M F must be investigated at once in the triangle F M E, namely from the three given sides. Once it is found, the angle L M E is to be taken from it, so that you have the angle A M F. Next, from the given distance of the comet and Palilicium, F M, and the angle A M F just obtained, you will compute the perpendicular F K and at the same time the side K M, so that the side A K results, namely by subtracting the side K M from the distance of Palilicium from the pole, A M. Finally, with A K and F K thus found, there results in the right-angled triangle F K A the complement of the latitude, A F, A F; and likewise, in the same triangle, the angle F A K, from the hypotenuse A F and the side F K. To this angle the difference of the longitudes of the comet and Palilicium, G N, is equal; it is to be taken from the longitude of Palilicium, and there will remain the longitude of the comet sought, ♈ G.

Diagram. An engraved figure set to the left of the prose, within a lighter rectangular plate impression. From A at the top arcs, circles of latitude, descend to the ecliptic, which runs across the foot; on it stand H, V, N, I and G from left to right, with the sign of Aries at its right end. The stars are drawn as asterisks: S, labelled "Capella", at the upper left; E, labelled "Cornu ♉." (the horn of Taurus), at the lower left; B, labelled "Pleiad." (the Pleiades), at the lower right, above the ecliptic; and M, labelled "Palilic." (Palilicium), below the ecliptic. The comet is a small circle at F, labelled "Cometa", at the right. Straight lines join S to F, E to F, E to M, F to M and F to B; dotted lines run

[92] the right-hand column of the check; "F Q" stands in the arc column on the page. The line for A F is printed "Compl. latit. Corn." although A F is the complement of the comet's latitude. The computed distance is printed "dist." before the figures and "Com.& *" after them; the star is printed as an asterisk.

from S to T, from K to F, from E to L, and from B to D. At the foot, right, stands the engraver's note "Autor Sculpſit" (the author engraved it).

- A (top): the north pole of the ecliptic
- S, Capella (upper left): Capella
- T (upper right, at the end of the dotted line from S): a point on a circle of latitude
- K (centre, at the end of the dotted line from F): a point on a circle of latitude
- F, Cometa (right): the comet
- E, Cornu ♉. (lower left): the horn of Taurus
- L (at the end of the dotted line from E): a point on a circle of latitude
- B, Pleiad. (lower right): the Pleiades
- D (at the end of the dotted line from B): a point on a circle of latitude
- ♈ (right end of the ecliptic): the sign of Aries
- H, V, N, I, G (on the ecliptic, left to right): points on the ecliptic
- M, Palilic. (below the ecliptic): Palilicium
- Autor Sculpſit (foot, right): the engraver's note

Line	Arc	Logarithm	Mark	Value	Remark
Side	E M	124379		16° 45′ 20″	
Side	F M	84706	*A.*	25° 23′ 0″	
Difference		209085		8° 37′ 40″	*first aggregate*
Side	F E			26° 34′ 0″	
Sum				35° 11′ 40″	
Half		119627		17° 35′ 50″	
Difference				17° 56′ 20″	
Half		185849	*A.*	8° 58′ 10″	
Second aggregate		305476			
First aggregate		209085	*S.*		
Remainder		96391			
Half		48195		38° 8′ 2″	
Whole angle	E M F			76° 16′ 4″	
Angle	L M E			49° 47′ 40″	
Angle	A M F			26° 28′ 24″	

93

Line	Arc	Loga-rithm	Mark	Value	Remark
Log.	F M	84706			
Log.	A M F	80792	*A.*		
Log. of the perpendicular	F K	165498		11° 1′ 0″	

[93]the left-hand column of the calculation. In the lines for the sides and halves the logarithms stand in a column to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Agg. … prius". The logarithm of the last half stands to the right of its degrees.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	F M	10152			
Antilog. of the perpendicular	F K	1860	*S.*		
Antilog.	K M	8292		23° 0′ 45″	
Distance of Palilicium from the pole	A M			95° 29′ 57″	
				72° 29′ 12″	*A K*
Antilog. of the perpendicular	F K	1860			
Antilog.	A K	120088	*A.*		
Antilog.	A F	121948		72° 49′ 10″	*compl. of the lat. of the comet*
Latitude of the comet sought				17° 10′ 50″	
Log. of the perpendicular	F K	165498			
Log.	A F	4565	*S.*		
Log.	F A K	160933		11° 32′ 18″	
Longitude of Palilicium	♈ N			64° 57′ 8″	
Longitude of the comet sought	♈ G			23° 24′ 50″ ♉	

94

Check of the comet's place by the distance of Capella, S, 22° 52′, observed on the same day at 1^h 44^m 10^s.

From the complement of the latitude of S, and the angle S A F, which the difference of the longitudes of Capella and the comet measures, let the perpendicular S T first be found; and likewise, from A S and S T, the side A T, which in turn is to be taken from the complement of the comet's latitude, and T F will remain. Then, with the two sides T F and the perpendicular S T given, the distance sought of the comet and Capella, F S, results.

[Margin: Examen calculi.] [The check of the calculation.]

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of Capella	S A			67° 7′ 45″	
Compl. of the lat. of the comet	A F			72° 49′ 10″	
Long. of the comet	♈ G			53° 24′ 50″	
Long. of Capella	♈ V			77° 0′ 12″	
Diff., or angle	T A S			23° 35′ 22″	
Logarithm	S A	8188			
Log. of the angle	T A S	91584	*A.*		
Log. of the perpendicular	S T	99772		21° 38′ 12″	

95

[94] the right-hand column of the calculation. "AK" is printed after the figures of the eighth line, not in the arc column. The remark on A F is printed "Cõpl." before the figures and "lat.Com." after them.

[95] the left-hand column of the check.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	S A	94509			
Antilog. of the perpendicular	S T	7306	*S.*		
Antilog.	A T	87203		65° 17′ 7″	
Compl. of the latit. of the comet	A F			72° 49′ 10″	
	T F			7° 32′ 3″	
Antilog.	T F	867			
Antilog. of the perpendicular	S T	7306	*A.*		
Antilog. of the distance of the comet		8173		22° 51′ 0″	*and Capella*
Observed distance of the comet and Capella				22° 52′ 0″	
Difference				1′ 0″	

96

Since the difference is only one minute, it is evident that the comet's place has been determined to a nicety. This is moreover confirmed more than enough by a check against the distance of the leading star of the Pleiades and the comet, which was found to be 13° 25′ at 1^h 53^m 9^s. For first, in the triangle D A B, the perpendicular B D is found from the complement of the latitude of the star, A B, and the angle D A B, which is equal to G I, the difference of the longitudes of the comet and the star; and likewise the side A D, from which A F, the complement of the comet's latitude, is to be taken, and the remainder will be F D. And so, from that side and the perpendicular B D, the distance itself of the comet and the star, F B, is found.

Line	Arc	Loga-rithm	Mark	Value	Remark
Compl. of the lat. of the leading star of the Pleiades	A B			86° 4′ 30″	
Long. of the comet	♈ G			53° 24′ 50″	
Long. of the leading star of the Pleiades	♈ I			55° 31′ 12″	
Angle	G A I			2° 6′ 22″	*or difference*
Log.	A B	235			
Log. of the angle	D A B	330361	*A.*		
Log. of the perpendicular	B D	330596		2° 6′ 4″	

97

[96] the right-hand column of the check; "T F" stands in the arc column on the page. The mark after 7306 in the second line is printed "S," with a comma. The computed distance is printed "Antil. dift. Com." before the logarithm and "& Capell." after the figures.

[97] the left-hand column of the check. The remark on G A I is printed "five differ." after the arc.

Line	Arc	Logarithm	Mark	Value	Re-mark
Antilog.	A B	268165			
Antilog. of the perpendicular	B D	67	*S.*		
Antilog.	A D	268098		86° 4′ 21″	
Complement of the lat. of the comet	A F			72° 49′ 10″	
	F D			13° 15′ 11″	
Antilog.	F D	2699			
Antilog. of the perpendicular	D B	67	*A.*		
Antilog. of the distance	F B	2766		13° 24′ 51″	
Observed distance of the comet and the star				13° 25′ 0″	
Difference				9″	

98

So you see that the distances agree still far more accurately. Indeed, even if the perpendicular falls within the triangle A F B, everything will nonetheless be equally accurate, as the following calculation clearly shows.

Line	Arc	Logarithm	Mark	Value	Re-mark
Log. of the compl. of the lat. of the comet	A F	4565			
Log. of the angle	G A I	330361	*A.*		
Log. of the perpendicular	F C	334926		2° 0′ 43″	
Antilog.	A F	121948			
Antilog.	F C	62	*S.*		
Antilog.	A C	121886		72° 48′ 30″	
Compl. of the latit. of the star	A B			86° 4′ 30″	
	C B			13° 16′ 0″	

99

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	C B	2705			
Antilog. of the perpendicular	F C	62	*A.*		
Antilog. of the distance		2767		13° 25′	*of the comet and the star*
The observed distance was				13° 25′	
Difference, none at all				0	

100

Observation 9. [Obfervatio 9.]

98 the right-hand column of the check; "F D" stands in the arc column on the page. The observed distance is printed "Com. & *", with the star as an asterisk.

99 the left-hand column of the calculation; "C B" stands in the arc column on the page.

100 the right-hand column of the calculation. The computed and observed distances are printed in degrees and minutes only; "Com. & Stellæ." stands after the first.

Given the comet's distances from the horn of Taurus, 28° 30′, and from Capella, 22° 46′, taken on December 29 at 4^h 5^m 50^s, let its longitude and latitude be sought.

In the adjoining figure, in which S is Capella, F the comet and E the horn of Taurus, let the angle F E S first be investigated (since the distance of Capella and the horn, together with the angle S E T, is already known from the calculation of the fifth observation on page 46); and when the angle S E T is added to it, the angle F E A will result. 2. In the triangle F E A, from the given distance of the comet and the horn, F E, and the angle F E A, let the perpendicular F K be sought, and the side K E from F K and F E. K E, subtracted from the complement of the latitude of the horn of Taurus, leaves the side A K. 3. In the triangle F A K, from F K and A K, let A F, the complement of the comet's latitude, be computed; and likewise, from the hypotenuse A F and the perpendicular F K, the angle F A K, or G H, the difference sought of the longitudes of the comet and the horn. It is to be taken, of course, from the longitude of the horn of Taurus, so that the longitude of the comet sought, ♈ G, results.

Diagram. An engraved figure in a ruled frame, set to the left of the prose. From A at the top arcs, circles of latitude, descend to the ecliptic, which runs across the foot; on it stand H and N at the left and G at the right, with the sign of Aries at its right end. The stars are drawn as asterisks: S, labelled "Capella.", at the upper left, and E, labelled "Cornu ♉" (the horn of Taurus), at the lower left. The comet is a small circle at F, labelled "Comet.", at the right. Straight lines join S to F, E to F, and S to E; dotted lines run from S to T and from K to F. At the foot, right, stands the engraver's note "Autor Sculpſ." (the author engraved it).

- A (top): the north pole of the ecliptic
- S, Capella. (upper left): Capella
- T (left, at the end of the dotted line from S): a point on a circle of latitude
- K (left, at the end of the dotted line from F): a point on a circle of latitude
- F, Comet. (right): the comet
- E, Cornu ♉ (lower left): the horn of Taurus
- H, N, G (on the ecliptic, left to right): points on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- Autor Sculpſ. (foot, right): the engraver's note[101]

Line	Arc	Logarithm	Mark	Value	Remark
Side	S E	119918		17° 33′	
Side	F E	73991		28° 30′	
Difference		193909		10° 57′	*first aggregate*
Side	F S			22° 46′	
Sum				33° 43′	
Half		123306		16° 56½′	

[101] a short vertical stroke stands inside the frame at the upper left; it is not read as a letter.

Line	Arc	Logarithm	Mark	Value	Remark
Difference				11° 49′	
Half		225969		5° 59½′	
Second aggregate		349275			
First aggregate		193909	*S.*		
Remainder		155366			
Half		77683		27° 22′ 43″	
Whole angle	F E S			54° 45′ 26″	
Angle	S E T			2° 13′ 1″	*A.*
Angle	F E A			56° 58′ 27″	

102

Line	Arc	Loga-rithm	Mark	Value	Remark
Log.	F E	73991			
Log. of the angle	F E A	17622	*A.*		
Log. of the perpendicular	F K	91613		23° 35′ 0″	
Antilog.	F E	12918			
Antilog. of the perpendicular	F K	8722	*S.*		
Antilog.	K E	4196		16° 29′ 8″	
Compl. of the latit. of the horn	A E			84° 39′ 30″	
	A K			68° 10′ 22″	
Antilog. of the perpendicular	F K	8722			
Antilog.	A K	98937	*A.*		
Antilog.	A F	107659		70° 4′ 39″	*compl. of the lat. of the comet*
Latitude of the comet sought, North	F G			19° 55′ 21″	
Log.	F K	91613			
Log.	A F	6171	*S.*		
Log.	F A K	85442		25° 11′ 3″	
Longitude of the upper horn	♉			77° 43′ 42″	
Longitude of the comet sought	♈ G			22° 32′ 39″ ♉	

103

Observation 10. [Obſervatio 10.]

From the nearly equilateral triangle which the comet forms with Algol and the star preceding it below Algol, on the same day, the 29th, at about 4 or 5 o'clock, let the comet's longitude and latitude be sought.

[102] the left-hand column of the calculation. In the lines for the sides and halves the logarithms stand in a column to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Agg. … prius.". The sides and halves are given in degrees and minutes only, the two halves with a printed ½.

[103] the right-hand column of the calculation; "A K" stands in the arc column on the page. The remark on A F is printed "Cõpl." before the figures and "lat.Com." after them.

In the adjoining drawing let F be the comet, S the Bright Star of Medusa, or Algol, and E the preceding star below Algol. Therefore, first, in the triangle A S E, let the perpendicular S T and the side T E be found in the usual way. 2. In the triangle

S T E, from the two sides just mentioned, the distance itself between Algol and the star preceding below Algol, E S, becomes known. 3. In the same triangle, from the hypotenuse S E and the perpendicular S T, the angle S E T is to be sought. 4. Once the one side E S has been found, everything in the triangle S E F is known at once, since the triangle is equilateral. From all these same sides, F E S, you will therefore compute the angle F E S; and when the angle T E S is added to it, the angle A E F results. 5. In the triangle F E A, find the perpendicular F K; and likewise, in the triangle F K E, from F E and F K, the side K E. When K E is subtracted from A E, A K remains. 6. Finally, in the right-angled triangle F K A, given F K and A K, the complement of the comet's latitude, A F, results; and also, from F K and A F, the angle F A K, the difference of the longitudes H G. If you add this to the longitude of the star preceding below Algol, you will have the longitude of the comet itself that was sought.

Diagram. An engraved figure in a ruled frame, to the right of the prose: the "adjoining drawing" named on p. 96. From A at the top three arcs, circles of latitude, descend to the ecliptic, which runs across the foot; they meet it at G, N and H, left to right, and the sign of Aries stands at the ecliptic's right end. The stars are drawn as asterisks: S on the middle arc, labelled "Algol", and E on the right arc, with K just above it and the label "Præced. ſub Algol" (the preceding star below Algol) engraved vertically beside it. T stands on the right arc, joined to S by a dotted line. The comet is a small circle at F on the left arc, labelled "Cometa"; a dotted line runs from F to K. Straight lines join S to F, S to E, and F to E. At the foot, right, stands the engraver's note "Autor Sculps." (the author engraved it).

- A (top): the north pole of the ecliptic
- S, Algol (middle arc): Algol
- T (right arc, at the end of the dotted line from S): a point on a circle of latitude
- F, Cometa (left arc): the comet
- K (right arc, just above E, at the end of the dotted line from F): a point on a circle of latitude
- E, Præced. ſub Algol (right arc): the star preceding below Algol
- G, N, H (on the ecliptic, left to right): points on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- Autor Sculps. (foot, right): the engraver's note

Line	Arc	Value	Remark
Longitude of Algol	♈ M	21° 21′ ♉	
Longitude of the preceding star below Algol	♈ H	20° 2′ ♉	

Line	Arc	Value	Remark
Difference, or angle	H A N	1° 19′	
Latitude of Algol		22° 22′ 30″	*North*
Compl. of the latitude		67° 37′ 30″	
Latitude of the preceding star below Algol		20° 33′ 30″	
Compl. of the latitude	A E	69° 26′ 30″	

104

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the compl. of the lat.	A S	3827			
Log. of the angle	H A N	377321	*A.*		
Log. of the perpendicular	S T	385148		1° 13′ 3″	
Antilog. of the compl. of the lat.	A S	96584			
Antilog. of the perpendicular	S T	23	*S.*		
Antilog.	A T	96561		67° 37′ 11″	
	A E			69° 26′ 30″	
	T E			1° 49′ 19″	
Antilog.	T E	50			
Antilog. of the perpendicular	S T	23	*A.*		
Antilog. of the distance	E S	73		2° 11′ 0″	*of the stars*
Log. of the perpendicular	S T	385148			
Log.	S E	326762	*S.*		
Log. of the angle	S E T	58386		33° 54′ 0″	
Side	S E	326762		2° 11′	
Side	F E	326762		2° 11′	
Difference		653524		0° 0′	*first aggregate*
Side	F K			2° 11′	
Sum				2° 11′	
Half		396061		1° 5½′	
Difference				2° 11′	
Half		396061		1° 5½′	
Second aggregate		792122			
First aggregate		653524			
Remainder		138598			

105

[104] the given positions, set on the page in three groups side by side: the two longitudes and their difference at the left, the latitude of Algol and its complement in the middle, the latitude of the preceding star and its complement at the right. "B." stands after the latitude of Algol.

[105] the left-hand column of the calculation. "A E" and "T E" stand in the logarithm column; "Stell." stands after "E S". In the lines for the sides and halves the logarithms stand to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Agg. … prius". The sides and halves are given in degrees and minutes only, the two halves with a printed ½.

Line	Arc	Logarithm	Mark	Value	Remark
Half		69299		30° 0′ 20″	
Whole angle	F E S			60° 0′ 40″	
Angle	T E S			33° 54′ 0″	
Angle	F E A			93° 54′ 40″	
Its complement to 180°				86° 5′ 20″	
Log.	F E	326762			
Log. of the angle	F E A	233	*A.*		
Log. of the perpendicular	F K	326995		2° 10′ 42″	
Antilog.	F E	73			
Antilog.	F K	73	*S.*		
Antilog.	K E	0		0° 0′ 0″	
Compl. of the latit. of the star preceding below Algol	A E			69° 26′ 30″	
	A K			69° 26′ 30″	
Antilog. of the perpendicular	F K	73			
Antilog.	A K	104651	*A.*		
Antilog.	A F	104724		69° 27′ 26″	*compl. of the lat. of the comet*
Latitude of the comet sought	F G			20° 32′ 34″	
Log.	F K	326995			
Log.	A F	6570	*S.*		
Log.	F A K	320425		2° 19′ 35″	*A*
Longitude of the star preceding below Algol				50° 2′ 0″	
Longitude of the comet sought				52° 21′ 35″	

106

However roughly this observation was made, and with the naked eye, it nevertheless agrees fairly precisely with the earlier calculation. Even so, the place found earlier is rightly to be preferred to this later one as the more accurate.

Observation 11. [Obſervatio 11.]

Given the comet's distances from Palilicium, 31° 45′, and from the horn of Taurus, 31° 4′, taken on December 30 in the evening at 6^{h} 10^{m} 30^{s}, let the comet's longitude and latitude be sought.

Since this calculation rests on exactly the same figure inserted above for the 8th observation, on page 50, and on entirely the same method and demonstration set out there, there is no need to repeat all of it again. It will be enough to

[106] the right-hand column of the calculation. In the first line "Log." stands between the logarithm and the degrees. The star preceding below Algol is marked by a printed asterisk in the line for A E; "A K" stands in the arc column. The remark on A F is printed "Cõpl." before the figures and "lat.Com." after them. No sign of the zodiac and no "B." are printed with the comet's latitude or longitude.

set out here only the bare calculation, both of the comet's true place and of its check.

Line	Arc	Logarithm	Mark	Value	Remark
Side	E M	124379		16° 45′ 20″	
Side	F M	64205	*A.*	31° 45′ 0″	
Difference		188584		14° 59′ 40″	*first aggregate*
Side	F E			31° 4′ 0″	
Sum				46° 3′ 40″	
Half		93850		23° 1′ 50″	
Difference				16° 4′ 20″	
Half		196757	*A.*	8° 2′ 10″	
Second aggregate		290607			
First aggregate		188584			
Remainder		102023			
Half-angle		51011		36° 54′ 3″	
Whole angle	E M F			73° 48′ 6″	
Angle	L M E			49° 47′ 40″	*S.*
Angle	A M F			24° 0′ 26″	

107

Line	Arc	Loga-rithm	Mark	Value	Remark
Log.	F M	64205			
Log.	A M F	89930	*A.*		
Log. of the perpendicular	F K	154135		12° 21′ 35″	
Antilog. of the hypotenuse	F M	16210			
Antilog. of the perpendicular	F K	2345	*S.*		
Antilog.	K M	13865		29° 28′ 43″	
Distance of Palilicium from the pole	A M			95° 29′ 57″	
	A K			66° 1′ 14″	
Antilog. of the perpendicular	F K	2345			
Antilog.	A K	90039	*A.*		
Antilog.	A F	92384		66° 36′ 43″	*compl. of the lat. of the comet*
Latitude of the comet sought	F G			23° 23′ 17″	
Log. of the perpendicular	F K	154135			
Log.	A F	8573	*S.*		
Log.	F A K	145562		13° 29′ 20″	
Longitude of Palilicium	♈ N			64° 57′ 8″	
Longitude of the comet sought	♈ G			21° 27′ 48″ ♉	

[107] the left-hand column of the calculation. In the lines for the sides and halves the logarithms stand to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Agg. … prius". The logarithm of the half-angle stands to the right of its degrees.

108

Check of the calculation by the distance of the comet and Capella, 23° 27′, observed on the same day at 6^h 41^m 50^s.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of Capella	S A			67° 7′ 45″	
Compl. of the lat. of the comet	A F			66° 36′ 43″	
Longitude of the comet	♈ G			51° 27′ 48″	
Longitude of Capella	♈ V			77° 0′ 12″	
Difference, or angle	T A S			25° 32′ 24″	
Logarithm	S A	8188			
Log. of the angle	T A S	84132	*A.*		
Log. of the perpendicular	S T	92320		23° 24′ 23″	

109

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	S A	94509			
Antilog. of the perpendicular	S T	8587	*S.*		
Antilog.	A T	85922		64° 56′ 43″	
Compl. of the latit. of the comet	A F			66° 36′ 43″	
	T F			1° 40′ 0″	
Antilog. of the perpendicular	S T	8587			
Antilog.	T F	42	*A.*		
Antilog. of the distance of the comet		8629		23° 27′ 45″	*and Capella*
Observed distance of the comet and Capella				23° 27′ 0″	
Therefore the difference is only				45″	

110

Another check of the calculation by the distance of the comet and the leading star of the Pleiades, observed at 6^h 54^m 29^s.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of the leading star of the Pleiades	A B			86° 4′ 30″	
Longitude of the comet	♈ G			51° 27′ 48″	
Longitude of the leading star of the Pleiades	♈ I			55° 31′ 12″	
Angle G A I, or difference				4° 3′ 34″	
Logarithm	A F	8573			

[108] the right-hand column of the calculation; "A K" stands in the arc column. The remark on A F is printed "Cõpl." before the figures and "lat.C." after them.

[109] the left-hand column of the check.

[110] the right-hand column of the check; "T F" stands in the arc column. The remark on the computed distance is printed "&" before the figures and "Capell." after them. The difference stands in the seconds column.

Line	Arc	Loga-rithm	Mark	Value	Re-mark
Log. of the angle	G A I	264799	*A.*		
Log. of the perpendicular	F C	273372		3° 43′ 32″	

111

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	A F	92384			
Antilog. of the perpendicular	F C	212	*S.*		
Antilog.	A C	92172		66° 33′ 26	
Compl. of the lat.	A B			86° 4′ 30″	
	C B			19° 31′ 4″	
Antilog.	C B	5917			
Antilog. of the perpendicular	F C	212	*A.*		
Antilog. of the distance	F B	6112		19° 51′ 22″	
Observed distance				19° 54′ 0″	
Difference				2′ 38″	

112

The reason why this difference of the distances is somewhat greater than the earlier one is that this distance from the leading star of the Pleiades was observed with the radius only, and moreover about 40^{m} later than the other intervals, namely those from Palilicium and the horn. The comet's place on this day, December 30, has therefore been derived very well.

Observation 12. [Obſervatio 12.]

Given the comet's distances from the horn of Taurus, 31° 25′, and from Capella, 23° 24′ 30″, taken on December 31 in the morning at 4^{h} 7^{m} 18^{s}, let its longitude and latitude be sought.

Just as the preceding calculation depends on the figure shown for observation 8 on page 50, so the figure inserted for observation 9 on page 52, together with what was adduced there for the demonstration, also serves this calculation of ours entirely. For this reason, this time too, we have set down here nothing but the bare calculation.

Line	Arc	Logarithm	Mark	Value	Remark
Side	S E	119918		17° 32′ 40″	
Side	F E	65151	*A.*	31° 25′ 0″	
Difference		185069		13° 52′ 20″	*first aggregate*
Side	F S			23° 24′ 30″	
Sum				37° 16′ 50″	
Half		114061		18° 38′ 25″	

[111] the left-hand column of the check. "G A I" stands with the label in the line for the angle.
[112] the right-hand column of the check; "C B" stands in the arc column. No seconds mark is printed after the 26 of A C.

Line	Arc	Logarithm	Mark	Value	Remark
Difference				9° 32′ 10″	
Half		248744		4° 46′ 5″	
Second aggregate		362805			
First aggregate		185069	*S.*		
Remainder		177736			
Half-angle		88868		24° 17′ 11″	*half*
Whole angle	F E S			48° 34′ 22″	
Angle	S E T			2° 13′ 1″	*A.*
Angle	F E A			50° 47′ 23″	

113

Line	Arc	Loga-rithm	Mark	Value	Remark
Log.	F E	65151			
Log. of the angle	F E A	25511	*A.*		
Log. of the perpendicular	F K	90662		23° 49′ 17″	
Antilog.	F E	15853			
Antilog. of the perpendicular	F K	8903	*S.*		
Antilog.	K E	6950		21° 6′ 54″	
Compl. of the latit. of the horn	A E			84° 39′ 30″	
	A K			63° 32′ 36″	
Antilog. of the perpendicular	F K	8903			
Antilog.	A K	80852	*A.*		
Antilog.	A F	89755		65° 56′ 57″	*compl. of the lat. of the comet*
Latitude of the comet sought	F G			24° 3′ 3″	
Log.	F K	90662			
Log.	A F	9081	*S.*		
Log.	F A K	81581		26° 15′ 2″	
Longitude of the upper horn	♉			77° 43′ 42″	
Longitude of the comet sought	♈ G			21° 28′ 40″ ♉	

114

Observation 13. [Obſervatio 13.]

Given the comet's distances from Palilicium, 34° 5′, and from the upper horn of Taurus, 32° 45′, taken on January 1 in the year 1653 at 2^{h} 52^{m} 49^{s}, let the comet's longitude and latitude be sought.

Since the comet's place is once again to be investigated from its distances from Aldebaran and from the horn of Taurus, as was done for observation 6 on

[113] the left-hand column of the calculation. In the lines for the sides and halves the logarithms stand to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Agg. … prius.". The logarithm of the half-angle stands to the right of its degrees, followed by "Semiſs.".

[114] the right-hand column of the calculation; "A E" and "A K" stand in the logarithm column. The remark on A F is printed "Cõpl." before the figures and "lat.Com." after them.

page 47, our calculation here certainly also enjoys the same demonstration and method, but, by reason of the check, a somewhat different figure. We therefore now add the calculation here, and indeed only its latter part. For the other quantities, namely the interval between Aldebaran and the horn, and likewise the angle L M E, are already evident from the calculation of observation 4 on page 43.

Line	Arc	Logarithm	Mark	Value	Remark
Side	E M	124379		16° 45′ 20″	
Side	F M	57911		34° 5′ 0″	
Difference		182290		17° 19′ 40″	*first aggregate*
Side	F E			32° 45′ 0″	
Sum				50° 4′ 40″	
Half		85984		25° 2′ 20″	
Difference				15° 25′ 0″	
Half		200858		7° 42′ 40″	
Second aggregate		286842			
First aggregate		182290			
Remainder		104552			
Half-angle		52276		36° 21′ 40″	*half*
Whole angle	E M F			72° 43′ 20″	
Angle	L M E			49° 47′ 40″	
Angle	A M F			22° 55′ 40″	
Log.	F M	57911			
Log.	A M F	94269	*A.*		
Log. of the perpendicular	F K	152180		12° 36′ 36″	
Antilog.	F M	18847			
Antilog. of the perpendicular	F K	2442	*S.*		
Antilog.	K M	16405		31° 55′ 47″	
Distance of Palilicium from the pole	A M			95° 29′ 57″	
	A K			63° 34′ 10″	
Antilog. of the perpendicular	F K	2442			
Antilog.	A K	80943	*A.*		
Antilog.	A F	83385		64° 15′ 17″	*compl. of the lat. of the comet*
Latitude of the comet sought, North				25° 44′ 43″	
Log. of the perpendicular	F K	152180			
Log.	A F	10455	*S.*		
Log. of the angle	F A K	141725		14° 1′ 39″	*S.*
Longitude of Palilicium	♈ N			64° 57′ 8″	
Longitude of the comet sought	♈ G			20° 55′ 29″ ♉	

115

Diagram. An engraved figure in a faint ruled frame, to the left of the calculation: the "somewhat different figure" for Observation 13 named on p. 99. From A at the top five arcs, circles of latitude, descend to the ecliptic, which runs across the foot; they meet it at H, V, N, G and B, left to right, and the sign of Aries stands at the ecliptic's right end. The stars are drawn as asterisks: D on the rightmost arc, under a cursive label beginning "In flexur. ad."; S, labelled "Capella."; E, labelled "Cornu ♉" (the horn of Taurus); and M below the ecliptic, labelled "Palilic." (Palilicium). The comet is a small circle at F, labelled "Cometa"; dotted lines run from F to T, to K and to C, and from E to L on the ecliptic. Straight lines join S to F, E to F, E to M, M to F and D to F. At the foot, right, stands the engraver's note "Autor Sculps." (the author engraved it).

- A (top): the north pole of the ecliptic
- D, In flexur. ad. Cox Caſ (upper right): a star, "in the bend at the hip of Cassiopeia" (the abbreviations taken as coxam Cassiopeiæ)
- T (left, at the end of a dotted line from F): a point on a circle of latitude
- K (centre, on a dotted line from F): a point on a circle of latitude
- F, Cometa (centre right): the comet
- C (right, at the end of a dotted line from F): a point on the rightmost circle of latitude
- S, Capella. (left): Capella
- E, Cornu ♉ (lower left): the horn of Taurus
- L (on the ecliptic, at the end of the dotted line from E): a point on the ecliptic
- H, V, N, G, B (on the ecliptic, left to right): points on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- M, Palilic. (below the ecliptic): Palilicium
- Autor Sculps. (foot, right): the engraver's note

Check of the calculation by the distance of the comet and Capella, 23° 24′, observed at about the same time, at 3^{h} 3^{m} 48^{s}.

1. In the adjoining figure, in which S is Capella, let the perpendicular F T be derived from A F, the complement of the comet's latitude, and the angle T A F, that is, the difference of the longitudes of the star and the comet. 2. In the same triangle A F T, from F T and A F, let the third side A T be investigated; when it is subtracted from S A, the complement of Capella's latitude, S T will result. 3. In the triangle F T S, with T S and F T thus known, the distance itself of the comet and Capella results.

[115] the calculation of Observation 13, set in a single column to the right of the figure. In the lines for the sides and halves the logarithms stand to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Agg. … prius.". The logarithm of the half-angle stands to the right of its degrees, followed by "Semiſ.". "A K" stands in the arc column. The remark on A F is printed "Cõpl." before the figures and "lat.C." after them.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of Capella	A S			67° 7′ 45″	
Compl. of the lat. of the comet	A F			64° 15′ 17″	
Longitude of Capella	♈ V			77° 0′ 12″	
Longitude of the comet	♈ G			50° 55′ 29″	
Difference, or angle	T A F			26° 4′ 43″	
Logarithm	A F	10455			
Log. of the angle	T A F	82188	*A.*		
Log. of the perpendicular	F T	92643		23° 19′ 35″	

116

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	A F	83385			
Antilog. of the perpendicular	F T	8527	*S.*		
Antilog.	A T	74858		61° 46′ 10″	
Compl. of the latit. of Capella	S A			67° 7′ 45″	
	S T			5° 21′ 45″	
Antilog.	T S	439			
Antilog. of the perpendicular	F T	8527	*A.*		
Antilog. of the distance of the comet		8966		23° 54′ 5″	*and Capella*
Observed distance of the comet and Capella				23° 54′ 0″	
Therefore the difference is no more than				5″	

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You see, then, friendly reader, that the comet's place for this day has been determined very precisely. But for the sake of greater certainty it is worth testing it in yet another way, namely by the distance of the comet from the star in the bend at the hips of Cassiopeia (since this interval too was observed at that time, at $3^{h}\ 15^{m}\ 47^{s}$), to see whether these distances also agree accurately. Accordingly, in the preceding figure let D be that star in Cassiopeia, at the hips. Let the computation follow the preceding analysis. First, in the triangle C A F, from A F, the complement of the comet's latitude, and the angle at A, which the difference of the longitudes of the star and the comet measures, let the perpendicular F C be sought. Next, in the same triangle, from the two given sides A F and F C, find the third side A C; subtract from it the complement of the star's latitude, so that you have D C. Finally, in the triangle D C F, both sides about the right angle being thus known, the distance sought between the star and the comet itself becomes known.

[Margin: Examen calculi.] (Check of the calculation.)

[116] the left-hand column of the check.

[117] the right-hand column of the check; "S T" stands in the arc column. The remark on the computed distance is printed "&" before the figures and "Capel." after them. The difference stands in the seconds column.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of the star	A D			41° 13′ 30″	
Longitude of the star	♈ B			39° 11′ 42″	
Longitude of the comet	♈ V			50° 55′ 29″	
Difference, or angle	B A G			11° 43′ 47″	
Log.	A F	10455			
Log. of the angle	B A G	159311	*A.*		
Log. of the perpendicular	F C	169766		10° 33′ 4″	

118

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	A F	83385			
Antilog. of the perpendicular	F C	1705	*S.*		
Antilog.	A C	81680		63° 46′ 42″	
Compl. of the lat. of the star	A D			41° 13′ 30″	
	D C			22° 33′ 2″	
Antilog.	D C	7954			
Antilog. of the perpendicular	F C	1705	*A.*		
Antilog. of the distance	F D	9659		24° 46′ 50″	*of the star and the comet*
Observed distance of the star and the comet				24° 46′ 0″	
Difference				50″	

119

Although the difference of the distances may seem to be about 50″, in itself, if you weigh the matter scrupulously, it is none. For the observed interval between the comet and the bend at the hips was noted some minutes later than those of the other stars, Palilicium and the horn of Taurus. Hence the observed interval also came out smaller by about a minute, as the comet gradually approached the star (as the following table of the comet's proper motion shows). And so this inquiry too confirms that the comet's place for this day has been derived exactly, which is what we wanted to show.

Observation 14. [Obſervatio 14.]

Given the comet's distances from Palilicium, 34° 5′, and from Capella, 23° 54′, taken on January 1 at 3^{h} 3^{m} 48^{s}, let the comet's longitude and latitude be sought.

In the seventh observation, on page 49, the comet's true place was likewise computed from the intervals of Palilicium and Capella, after a preliminary demonstration. Since in this case too the demonstration and the method of

[118] the left-hand column of the check.

[119] the right-hand column of the check; "D C" stands in the arc column. The remark on the computed distance is printed "Stell." before the figures and "& C." after them. The difference stands in the seconds column. A stray label "Antil.AF" is printed to the left of the column, between the two columns, level with "Differentia".

calculation are entirely the same, I refer to what was said there at length. Moreover, since the distance of these stars, and likewise the angle V M S, are already established from that observation, let us begin this calculation by computing the angle F M S in the oblique-angled triangle S M F, from all its sides given; but we shall present another figure for the check to be made by the distance of the horn of Taurus and the comet.

Line	Arc	Logarithm	Mark	Value	Remark
Side	S M	67169		30° 43′ 13″	
Side	F M	57911		24° 5′ 0″	
Difference		125080		3° 21′ 47″	*aggregate*
Side	F S			23° 54′ 0″	
Sum				27° 15′ 47″	
Half		144652		13° 37′ 53″	
Difference				20° 32′ 13″	
Half		172452		10° 16′ 6″	
Second aggregate		317104			
First aggregate		125080			
Remainder		192024			
Half-angle		96012		22° 30′ 36″	*half*
Whole angle	F M S			45° 1′ 12″	
Angle	S M V			22° 7′ 17″	
Angle	F M A			22° 53′ 55″	

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Line	Arc	Logarithm	Mark	Value	Re-mark
Log.	F M	57911			
Log.	A M F	94386	*A.*		
Log. of the perpendicular	F K	152297		12° 35′ 36″	
Antilog. of the hypotenuse	F M	18847			
Antilog. of the perpendicular	F K	2435	*S.*		
Antilog.	K M	16412		31° 56′ 10″	
Distance of Palilicium from the pole	A M			95° 29′ 57″	
	A K			63° 33′ 47″	
Antilog. of the perpendicular	F K	2435			
Antilog.	A K	80921	*A.*		
Antilog.	A F	83356		64° 13′ 48″	
Latitude of the comet sought				25° 46′ 12″	*North*
Log. of the perpendicular	F K	152297			

[120] the left-hand column of the calculation of Observation 14. In the lines for the sides and halves the logarithms stand to the right of the degrees, each preceded by "Log."; the logarithm of the first difference is preceded by "Agg.". The logarithm of the half-angle stands to the right of its degrees, preceded by "Semis.". The side F M is printed 24° 5′ 0″; the caption of the observation on p. 101 gives the distance from Palilicium as 34° 5′, and the difference printed below, 3° 21′ 47″, is 34° 5′ 0″ − 30° 43′ 13″ (recte: 34° 5′ 0″).

Line	Arc	Logarithm	Mark	Value	Remark
Log.	A F	10477	*S.*		
Log.	F A K	141820		14° 0′ 47″	
Longitude of Palilicium	♈ N			64° 57′ 8″	
Longitude of the comet sought	♈ G			20° 56′ 21″ ♉	

121

Diagram. An engraved figure in a faint ruled frame, below the left-hand column of the calculation and beside the prose that follows: the "other figure" for the check of Observation 14 promised on p. 101. From A at the top four arcs, circles of latitude, descend to the ecliptic, which runs across the foot: the leftmost through E to H, the second through S to T, the third through K and V to N and on below the ecliptic to M, the rightmost through F to G; the sign of Aries stands at the ecliptic's right end. The stars are drawn as asterisks: S, labelled "Capella"; E, labelled "Corn. ♉" (the horn of Taurus); and M below the ecliptic, with a label read as P[?]lilicium (Palilicium). The comet is a small circle at F, labelled "Com." (the comet). Dotted lines run from L to F, from K to F and from S to V. Straight lines join S to F, E to F, S to M and F to M. At the foot, right, stands the engraver's note "Aut Sculps." (the author engraved it).

- A (top): the north pole of the ecliptic
- L (left, at the end of a dotted line from F): a point on the second circle of latitude
- F, Com. (upper right): the comet
- K (centre, at the end of a dotted line from F): a point on the third circle of latitude
- V (centre, at the end of a dotted line from S): a point on the third circle of latitude
- S, Capella (left): Capella
- E, Corn. ♉ (lower left): the horn of Taurus
- N (on the ecliptic): a point on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- G (on the ecliptic, right): a point on the ecliptic
- H, T (on the ecliptic, left): points on the ecliptic
- M, P[?]lilicium. (below the ecliptic): Palilicium; the second letter of the label not settled
- Aut Sculps. (foot, right): the engraver's note

That the comet's place found in the preceding calculation exceeds by about a minute is, you should know, because the observations of Palilicium and Capella were not taken together at the same moment of time; the later one, namely Capella's, was taken about half an hour later. But if, in turn, the comet's place is

[121] the right-hand column of the calculation; "A K" stands in the arc column. The latitude is followed by "Bor.". The longitude ends with the sign of Taurus.

derived from the horn and Capella, between whose observations not so long an interval of time elapsed, as the following calculation will show, you will see that everything agrees, to the seconds, with the earlier calculation of Observation 13. But before we come to that, let us bring the place just found to the test of the distance of the horn and the comet. So we must first seek the perpendicular F L, then L E, and so finally, in the triangle L F E, from the two given sides F L and L E that form the right angle, the distance F E of the comet and the horn, in the usual way.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of the horn of ♉	A E			84° 39′ 30″	
Compl. of the lat. of the comet	A F			64° 13′ 48″	
Longitude of the horn of ♉	♈ H			77° 43′ 42″	
Longitude of the comet	♈ G			50° 56′ 21″	
Difference, or angle	F A E			26° 47′ 21″	
Logarithm	A F	10477			
Log. of the angle	F A E	79692	*A.*		
Log. of the perpendicular	F L	90169		23° 56′ 47″	

122

Line	Arc	Loga-rithm	Mark	Value	Remark
Antilog.	A F	83356			
Antilog. of the perpendicular	F L	8999	*S,*		
Antilog.	A L	74357		61° 36′ 49″	
Compl. of the latit. of the horn	A E			84° 39′ 30″	
	L E			23° 2′ 41″	
Antilog.	E L	8316			
Antilog. of the perpendicular	F L	8999			
Antilog. of the distance	F E	17315		32° 45′ 10″	*and Capella*
Observed distance of the comet and the horn				32° 45′ 30″	
Difference, only				20″	

123

Observation 15. [Obſervatio 15.]

Given the comet's distances from Capella, 23° 54′, and from the horn of Taurus, 32° 45′ 30″, taken on the same day, January 1, and at the same hour, 3^h 3^m 48^s, let the comet's longitude and latitude be sought.

For greater confidence in the matter, it will be no trouble to investigate the comet's place once more from the earlier distances, but with them exchanged,

[122] the left-hand column of the check.

[123] the right-hand column of the check; "L E" stands in the arc column. The second antilogarithm of the perpendicular carries no mark. The remark on the computed distance F E is printed "& Capell." after the figures, although the line computes the distance of the comet and the horn. The difference stands in the seconds column.

namely from those of Capella and the horn, and also to examine that place afterwards by the interval to the bend at the hips of Cassiopeia. For undertaking this calculation we already have to hand, set out in Observation 5 above, on page 46, both the distance of these stars, Capella and the horn, and the angle S E T. So let us proceed at once to seek the angle F E S in the oblique-angled triangle E S F, all of whose sides are known; and once it is found, let us add to it the angle S E T, to make F E A. Next, in the triangle F E A, from F E, the distance of the horn and the comet, and from the angle F E A, let the perpendicular F K be found; and at the same time, in the triangle F E K, from the two given sides F E and F K, the side K E. Let this be subtracted from the complement of the latitude of the horn, and the side A K will result. Further, in the triangle F A K, let the hypotenuse A F, namely the complement of the comet's latitude, be sought from the remaining sides F K and A K; and likewise the angle in the same triangle F A K, namely the difference of the longitudes of the comet and the horn, again from the two sides A F and F K now known. When this is taken from the longitude of the horn, the comet's longitude sought will remain.

Diagram. An engraved figure in a faint ruled frame, to the right of the narrow measure of the prose. From A at the top four arcs, circles of latitude, descend to the ecliptic, which runs across the foot: the leftmost through K and E to H, the second through S to V, the third through F to G, the rightmost through D and C to B; the sign of Aries stands at the ecliptic's right end. The stars are drawn as asterisks: D, under the cursive label "In flex. ad Cox. Ca[?]." (in the bend at the hips of Cassiopeia; the form of its last two s-sorts not settled); S, labelled "Capella."; and E, labelled "Cornu ♉" (the horn of Taurus). The comet is a small circle at F. Dotted lines run from K to F, from F to C and from T to S. Straight lines join D to F, S to F, E to F and E to S. At the foot, right, stands the engraver's note "Autor [?]culps." (the author engraved it), its second word's initial a tall cursive form not settled between S and ſ.

- A (top): the north pole of the ecliptic
- D, In flex. ad Cox. Ca[?]. (upper right): the star in the bend at the hips of Cassiopeia
- K (left, at the end of a dotted line from F): a point on the leftmost circle of latitude
- C (right, at the end of a dotted line from F): a point on the rightmost circle of latitude
- T (left, at the end of a dotted line from S): a point on the leftmost circle of latitude
- S, Capella. (left): Capella
- F (centre): the comet
- E, Cornu ♉ (lower left): the horn of Taurus
- H, V, G, B (on the ecliptic, left to right): points on the ecliptic
- ♈ (right end of the ecliptic): the sign of Aries
- Autor [?]culps. (foot, right): the engraver's note

Line	Arc	Logarithm	Mark	Value	Remark
Side	S E	119918		17° 32′ 40″	
Side	F E	61414		32° 45′ 30″	
Difference		181332		15° 12′ 50″	*first aggregate*
Side	F S			23° 54′ 0″	
Sum				39° 6′ 50″	
Half		109438		19° 33′ 25″	
Difference				8° 41′ 10″	
Half		258060		4° 20′ 35″	
Second aggregate		367498			
First aggregate		181332			
Remainder		186166			
Half-angle		93083		23° 13′ 4″	
Whole angle	F E S			46° 26′ 8″	
Angle	S E T		*A.*	2° 13′ 1″	
Angle	F E A			48° 39′ 9″	

124

Line	Arc	Logarithm	Mark	Value	Remark
Log.	F E	61414			
Log. of the angle	F E A	28673	*A.*		
Log. of the perpendicular	F K	90087		23° 58′ 3″	
Antilog.	F E	17321			
Antilog. of the perpendicular	F K	9016	*S.*		
Antilog.	K E	8305		23° 1′ 45″	
Compl. of the latit. of the horn	A E			84° 39′ 30″	
	A K			61° 37′ 35″	
Antilog.	F K	9016			
Antilog.	A K	74397	*A.*		
Antilog.	A F	83413		64° 15′ 45″	
Latitude of the comet sought	F G			25° 44′ 25″	
Log.	F K	90087			
Log.	A F	10449	*S.*		
Log.	F A K	79638		26° 48′ 18″	
Longitude of the horn of ♉				77° 43′ 42″	
Longitude of the comet sought	♈ G			20° 55′ 24″ ♉	

125

This place of the comet agrees so precisely, especially with the one derived on page 56 in Observation 13, that nothing could be better: it differs by no

[124] the left-hand column of the calculation of Observation 15. In the lines for the sides and halves the logarithms stand to the right of the degrees, each preceded by "Log."; the first aggregate is printed "Aggr. … prius.". The logarithm of the half-angle stands to the right of its degrees with no prefix. The mark "A." stands after the seconds of the angle S E T.

[125] the right-hand column of the calculation; "A K" stands in the arc column. The longitude of the horn carries no arc letters. The comet's longitude ends with the sign of Taurus.

more than 5″ in longitude, while in latitude the later one is greater by 18″; but that arises necessarily from the proper motion. So the comet's place for this day has been derived as accurately [recte: accuratè, printed accutatè] as could ever be done. The following check bears this out as well.

Check of the comet's true place by the distance of the bend at the hips of Cassiopeia, 24° 46′, observed on the same day at 3^h 15^m 47^s.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of the star	A D			41° 13′ 30″	
Compl. of the lat. of the comet	A F			64° 15′ 45″	
Longitude of the star	♈ B			39° 11′ 42″	
Longitude of the comet	♈ G			50° 55′ 25″	
Difference, or angle	B A G			11° 43′ 43″	
Logarithm	A F	10449			
Log. of the angle	B A G	159320	*A.*		
Log. of the perpendicular	F C	169769		10° 33′ 3″	

126

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	A F	83413			
Antilog. of the perpendicular	F C	1705	*S.*		
Antilog.	A C	81708		63° 47′ 11″	
Compl. of the latit. of the star				41° 13′ 30″	
	D C			22° 33′ 41″	
Antilog.	D C	7962			
Antilog. of the perpendicular	F C	1705	*A.*		
Antilog. of the distance	F D	9667		24° 47′ 25″	
Observed distance of the comet and the star				24° 46′ 0″	
Difference				1′ 25″	

127

This difference of a minute arises only from the interval of about 15 minutes of time that elapsed between this observation and the earlier ones. For, as the following table of the comet's proper motion attests, its hourly motion at that time was 4′ in one hour. So the interval of the star and the comet observed at 3^h 15^m 47^s was necessarily also about a minute smaller than it would have been had it been taken at 3^h 3^m 48^s.

Observation 16. [Obſervatio 16.]

Given the comet's distances from Capella, 24° 22′, and from the left knee of Perseus, 12° 31′, taken on January 2 at about 6^h 27^m 30^s, let the comet's longitude and latitude be sought.

[126] the left-hand column of the check.

[127] the right-hand column of the check; "D C" stands alone to the right of the label column. The complement of the star's latitude carries no arc letters.

In the adjoining figure let F be the comet, S Capella, E the left knee of Perseus, C Algol, and B the left side of Perseus. Therefore, first, from the difference of the longitudes of Capella and the left knee of Perseus, and also from the complement of Capella's latitude, the perpendicular S T is to be found in the triangle A T S; and likewise the side A T, namely from A S and the perpendicular S T just found. Subtract A T from A E, the complement of the latitude of Capella, and the remainder will be T E. Then, the two sides about the right angle at T in the triangle E T S being thus known, the distance of these stars, Capella and the left knee of Perseus, results; and likewise the angle T E S, but from the given hypotenuse E S and the other side S T. Now in the triangle F E S all three sides are known: E S from the preceding resolution, the others from observation; so the angle F E S will also be established. Subtract from it the angle T E S, and you will have the angle F E A; so that from it and from F E, the distance of the comet and the knee of Perseus, you can in turn derive the perpendicular F K in the triangle F E K, and at the same time E K from the remaining two sides. To obtain the side A K, E K must be subtracted from E A, the complement of the latitude of the knee of Perseus. Finally, in the triangle F K A, the two sides forming the right angle being thus known, you will compute the hypotenuse A F, the complement, that is, of the comet's latitude. Then, also in the same triangle, from the hypotenuse A F just found and the side F K, you will compute the angle F A K, which is exactly equal to the difference of longitude G N of the comet and the knee of Perseus. If, finally, this difference is taken from the longitude of the left knee of Perseus, the comet's longitude itself, which was sought, results.

Diagram. An engraved figure in a faint ruled frame, to the right of the calculation, for Observation 16 and its check. From A at the top five arcs, circles of latitude, descend to the ecliptic, which runs across the foot from H to the sign of Aries at its right end: the leftmost, curved, through S to H; the second through K, T and E to N; the third through B to M; the fourth through the star labelled "Algol." to P; the rightmost through F and D to G. The stars are drawn as asterisks: B, under the cursive label "Latus Sin Perſei." (the left side of Perseus); S, labelled "Capella"; E, labelled "Genu Sin. Persei" (the left knee of Perseus); and an unlettered star labelled "Algol.". The comet is a small circle at F, labelled "Cometa." (the comet). Dotted lines run from B to I, from K to F, from S to T and from the star Algol to D. Straight lines join B to F, S to F, S to E, E to F and F to the star Algol. At the foot, right, stands the engraver's note "Autor Sculps." (the author engraved it). No letter C is engraved, although the text and the calculation use C (for Algol in the text).

- A (apex): A
- above B: Latus Sin Perſei. (the left side of Perseus)
- B (asterisk): B
- I (right of B, end of the dotted line): I
- K (left of the second arc): K
- F (comet, small circle): F; label "Cometa." (the comet)

- S (asterisk, left): S; label "Capella"
- T (on the second arc, end of the dotted line from S): T
- beside the star on the fourth arc: Algol.
- D (on the rightmost arc, end of the dotted line from Algol): D
- E (asterisk): E; label "Genu Sin. Persei" (the left knee of Perseus)
- on the ecliptic, left to right: H, N, M, P, G, and the sign ♈
- foot, right: Autor Sculps. (the author engraved it)

Line	Arc	Loga-rithm	Mark	Value	Remark
Longitude of Capella	♈ H			77° 0′ 12″	
Longitude of the knee of Perseus	♈ N			60° 52′ 12″	
Difference, or angle	N A H			16° 8′ 0″	
Log. of the compl. of the lat. of Capella	A S	8188			
Log. of the angle	H A N	128059	*A.*		
Log. of the perpendicular	S T	136247		14° 50′ 4″	
Antil. of the compl. of the lat.	A S	94509			
Antil. of the perpendicular	S T	3389	*S.*		
Antilogarithm	A T	91120		66° 17′ 21″	
Compl. of the latit. of the knee of Perseus	A E			70° 56′ 0″	
	T E			4° 38′ 39″	
Antil.	T E	329			
Antil. of the perpendicular	S T	3398	*A.*		
Antil. of the distance	E S	3727		15° 33′	of Capella and the knee of Perseus
Log. of the perpendicular	S T	136247			
Log. of the distance	E S	131647	*S.*		
Log. of the angle	T E S	4600		72° 45′ 13″	
Side	E S	131647		15° 33′	Log.
Side	F E	152913		12° 31′	Log.
Difference		284560		3° 2′	Aggregate, first
Side	F S			24° 22′	
Sum				27° 24′	
Half		144038		13° 42′	Log.
Difference				21° 20′	
Half		168689		10° 40′	Log.
Second aggregate		312727			
First aggregate		284560			
Remainder		28167			
Half-angle		14083		60° 18′ 0″	
Whole angle	F E S			120° 36′ 0″	
Angle	T E S			72° 45′ 13″	
Angle	F E A			47° 50′ 47″	

Line	Arc	Loga-rithm	Mark	Value	Remark
Log.	F E	152913			
Log.	F E A	29923	*A.*		
Log. of the perpendicular	F K	182836		9° 14′ 46″	
Antil.	F E	2405			
Antil. of the perpendicular	F K	1308	*S.*		
Antil.	E K	1097		8° 28′ 15″	
Compl. of the latit. of the knee of Perseus	E A			70° 56′ 0″	
	A K			62° 27′ 45″	
Antil. of the perpendicular	F K	1308			
Antil.	A K	77146	*A.*		
Antil.	A F	78454		62° 51′ 0″	Compl. of the lat. of the comet
Latitude of the comet sought	F G			27° 9′ 0″	North
Log. of the perpendicular	F K	182836			
Log.	A F	11674	*S.*		
Log.	F A K	171162		10° 24′ 11″	
Longitude of the left knee of Perseus				60° 52′ 12″	
Longitude of the comet sought				20° 28′ 0″ ♉	

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Line	Arc	Value
Latitude of Capella	H S	22° 52′ 15″
Compl. of the latit.	A S	67° 7′ 45″

Line	Value
Latitude of the left knee of Perseus	19° 4′ 0″
Compl. of the lat. of the same	70° 56′ 0″

129

Making the check by the distance of Algol, we shall find in the adjoining figure, in its triangle D A C, the perpendicular D C: given, namely, the angle D A C, the difference of longitude of the comet and of the side of Perseus, and

[128] one long column down the left half of the page. In the remark of the row for the distance E S the value stands between the two names (”Capel. 15° 33′ & gen. Perſ.”). In the rows for the sides E S and F E and for the two halves, the logarithm stands to the right of the degrees after ”Log.”; in the first ”Difference” row, after ”Agg.” and followed by ”prius.”. In the row for the antilogarithm of A F, ”Cōpl.” stands before the degrees and ”lat. C.” after them. The rows for T E and A K carry arc letters only.

[129] these two groups stand to the right of the first two rows of the calculation, across the head of it.

A C, the complement of the latitude of Algol. Then, in the same triangle, the side A D becomes known from A C and D C; from it the complement of the comet's latitude must be subtracted, so as to have D F. And so, from that side, together with D C, which forms the right angle with it, the distance sought between the comet and the left side of Perseus becomes known.

[Margin: Examen calculi.] (Check of the calculation.)

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the latit. of Algol	A C			67° 37′ 30″	
Compl. of the lat. of the comet	A F			62° 51′ 0″	
Longitude of the comet	♈ G			50° 28′ 0″	
Longitude of Algol	♈ P			51° 21′ 12″	
Difference, or angle	D A C			0° 52′ 12″	
Log.	A C	7827			
Log. of the angle	D A C	418756	*A.*		
Log. of the perpendicular	C D	426583		0° 48′ 16″	

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Line	Arc	Logarithm	Mark	Value	Remark
Antil.	A C	96513			
Antil. of the perpendicular	C D	10	*S.*		
Antil.	A D	96503		67° 36′ 22″	
Compl. of the latit. of the comet	A F			62° 51′ 0″	
	F D			4° 45′ 22″	
Antil.	F D	345			
Antil. of the perpendicular	C D	10	*A.*		
Antil. of the distance	F C	355		4° 50′ 0″	
Observed distance				4° 52′ 0″	
Difference				2′ 0″	

131

This difference of two minutes is surely of no weight; Tycho himself, the leader of the astronomers, agrees, in his *Progymnasmata* on the comet, pages 50, 54, 62 and elsewhere. For although it often happened to him there that the discrepancy of the distances grew to 3 and 4 minutes, he nevertheless holds that such a divergence takes nothing at all away from the comet's true place.

[Margin: Vnius aut alterius minuti differentiam Tycho inCometis non attendit.] (Tycho pays no attention to a difference of one minute or another in comets.)

But let us submit the comet's place found above to yet another check, and investigate whether the distance of the comet and the left side of Perseus, deduced by calculation, also corresponds exactly to the same distance observed

[130] the left-hand column of the check by the distance of Algol.
[131] the right-hand column of the check; "F D" stands alone, with no label.

at 5^h 53^m 30^s. Let the perpendicular B I therefore be sought, as before, given namely the angle I A B, to which the difference of longitude of the comet and the star is equal, and the complement of the side of Perseus; and at the same time A I, in the usual way. When A I is subtracted from the complement of the comet's latitude, the side I F remains. Finally, from this side and B I, the distance sought between the comet and the side of Perseus is found.

Line	Arc	Logarithm	Mark	Value	Re-mark
Compl. of the latit. of the side of Perseus	A B			59° 54′ 30″	
Longitude of the comet				50° 28′ 0″	
Longitude of the star				57° 1′ 12″	
Difference, or angle	I A B			6° 33′ 12″	
Log.	A B	14476			
Log. of the angle	I A B	217094	*A.*		
Log. of the perpendicular	B I	231570		5° 40′ 0″	

132

Line	Arc	Logarithm	Mark	Value	Remark
Antil.	A B	69037			
Antil. of the perpendicular	B I	490	*S.*		
Antil.	A I	68547		59° 44′ 43″	
Complement of the lat. of the comet	A F			62° 51′ 0″	
	I F			3° 6′ 17″	
Antil.	I F	146			
Antil. of the perpendicular	B I	490	*A.*		
Antil. of the distance		636		6° 27′ 0″	
The observed distance was				6° 27′ 0″	
Difference, none at all				0′ 0″	

133

It must therefore be admitted that the comet's true place has been established in the best way of all.

[Margin: Obſervationes adamuſim reſpondent.] (The observations agree to a hair.)

Observation 17 [Obſervatio 17.]

Given the comet's distances from the left side of Perseus, 6° 1′, and from Algol, 6° 45′, taken on January 3 at 6^h 47^m 30^s in the evening, let the comet's longitude and latitude be sought.

[132] the left-hand column of the check by the distance of the left side of Perseus. The first label reads "Compl.latit.lat.Perſei." as printed.

[133] the right-hand column of the check; "I F" stands alone, with no label, and the antilogarithm of the distance carries no arc letters.

And now too it falls to us to demonstrate this calculation from an entirely different figure, bearing in mind that so far we have not yet had occasion to find the comet's place from the distances of these fixed stars. Let F, then, be the comet, B the left side of Perseus, C Algol or the head of Medusa, S Capella, and L the horn of Taurus. Hence the triangle A E B must be considered first; in it are given A B, the complement of the latitude of Perseus, and the angle A, the difference of the longitudes of Algol and the other star; therefore E B results, and also A E, from the remaining two sides. Once the side A E has been found and subtracted from A C, E C will remain; together with E B, this gives the distance of the fixed stars Algol and the left side of Perseus. In turn, from this distance and the side E B, the angle E C B is found. Second: in the triangle F C B, its three sides being thus known, the angle F C B becomes known; from it the angle E C B just found is to be taken away, so that you have the angle F C A. Further, in the right-angled triangle F C K, let the perpendicular F K be derived, given namely F C and the angle F C A just found; and likewise the side K C, from the remaining sides, of course. Let this, moreover, be subtracted from the complement of the latitude of the head of Medusa, and the side A K remains. Finally, in the triangle F A K, from the two sides about the right angle, let the hypotenuse A F be sought, that is, the complement of the comet's latitude; and at the same time the angle F A K, but from A F and F K. If you take this angle from the longitude of Algol, the comet's longitude itself, which was sought, will result.

Diagram. An engraved figure in a faint ruled frame, to the right of the narrow measure of the prose, for Observation 17. From A at the top arcs, circles of latitude, descend to the ecliptic, which runs across the foot from R to the sign of Aries at its right end: two arcs on the left, close together, the outer passing the sign ♉ near its top and L near its foot to R, the inner passing I and S to H; an arc through B to M; an arc through E and C to P; and the rightmost through F to G. K stands left of F, at the arc through C. The stars are drawn as asterisks: B, under the cursive label "Lat. Persei." (the side of Perseus); S, labelled "Capella."; C, labelled "Algol."; and L, labelled "Cornu ♉." (the horn of Taurus). The comet is a small circle at F, labelled "Cometa." (the comet). Dotted lines run from B to E and from K to F, and two long dotted lines run from the two left-hand arcs, near the sign ♉ and near I, towards B and F; where each of these two ends is not settled. Straight lines join B to F, B to C, F to C, S to F and L to F. At the foot, right, stands the engraver's note "Autor Sculpsit." (the author engraved it).

- A (apex): A
- upper left, at the outer left-hand arc: ♉ (an engraved sign of the same form as the one in "Cornu ♉.")
- I (on the inner left-hand arc): I
- above B: Lat. Persei. (the side of Perseus)
- B (asterisk): B
- E (right of B, end of the dotted line): E

- K (left of F): K
- F (comet, small circle): F; label "Cometa." (the comet)
- S (asterisk): S; label "Capella."
- C (asterisk): C; label "Algol."
- L (asterisk): L; label "Cornu ♉." (the horn of Taurus)
- on the ecliptic, left to right: R, H, M, P, G, and the sign ♈
- foot, right: Autor Sculpsit. (the author engraved it)

Line	Arc	Loga-rithm	Mark	Value	Remark
Longitude of the side of Perseus	♈ M			57° 1′ 12″	
Longitude of Algol	♈ P			51° 21′ 0″	
Difference, or angle	P A M			5° 40′ 12″	
Log. of the compl. of the lat.	A B	14476			
Log. of the angle	P A M	231526	*A.*		
Log. of the perpendicular	B E	246002		4° 54′ 0″	
Antilogarithm	A B	69038			
Antil. of the perpendicular	B E	366	*S.*		
Antil.	A E	68672		59° 46′ 0″	
Compl. of the latit. of Algol	A C			67° 37′ 30″	
	E C			7° 51′ 30″	
Antil.	E C	941			
Antil. of the perpendicular	B E	366	*A.*		
Antil. of the distance	B C	1307		9° 15′ 0″	Algol and the lat. P.
Log. of the perpendicular	B E	246002			
Log.	B C	182795	*S.*		
Log. of the angle	E C B	63207		32° 6′ 21″	
Side	B C	182795		9° 15′ 0″	Log.
Side	F C	214100		6° 45′ 0″	Log.
Difference		396895		2° 30′ 0″	Aggregate, first
Side	F B			6° 1′ 0″	
Sum				8° 31′ 0″	
Half		260027		4° 15′ 30″	Log.
Difference				3° 31′ 0″	
Half		347403		1° 45′ 30″	Log.
Second aggregate		607430			
First aggregate		396895			
Remainder		210535			

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[134] the left-hand column of the calculation. In the row for the distance B C, "Algol." stands after the arc letters and "& lat. P." after the logarithm, so that the label reads "distance B C of Algol and the lat. P."; "lat. P." is left unexpanded. In the rows for the sides and the halves, the logarithm stands to the right of the degrees after "Log."; in the first "Difference" row, after "Agg." and followed by "prius".

Line	Arc	Value
Latitude of the side of Perseus		30° 5′ 30″
Compl. of the latit.	A D	59° 54′ 30″

Line	Arc	Value
Latitude of Algol		22° 22′ 30″
Compl. of the lat.	A C	67° 37′ 30″

135

Line	Arc	Logarithm	Mark	Value	Remark
Half		105267		20° 25′ 40″	
Whole angle	F C B			40° 51′ 20″	
Angle	E C B			32° 6′ 21″	
Angle	F C A			8° 44′ 59″	
Log.	F C	214100			
Log. of the angle	F C A	188306	*A.*		
Log. of the perpendicular	F K	402406		1° 1′ 28″	
Antil.	F C	696			
Antil. of the perpendicular	F K	16	*S.*		
Antil.	K C	680		6° 40′ 30″	
Compl. of the latit. of Algol	A C			67° 37′ 30″	
	A K			60° 57′ 0″	
Antil. of the perpendicular	F K	16			
Antil.	A K	72243			
Antil. of the compl. of the lat.	A F	72259		60° 57′ 20″	
Latitude of the comet sought				29° 2′ 40″	
Log.	F K	402406			
Log.	A F	13439	*S.*		
Log.	F A K	388967		1° 10′ 19″	G P
Longitude of Algol				51° 21′ 0″	
Longitude of the comet sought				20° 10′ 41″ ♉	

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It will now be worth while to weigh this place carefully as well, first by the distance of the comet and the horn, 35° 15′, observed at 6^{h} 56^{m}. Accordingly, given the complement of the comet's latitude and the angle G A R, namely the difference of the longitudes, the perpendicular F Q is found in the triangle F A Q; and likewise A Q, from the other known sides. Then subtract this side A

[135] these two groups stand to the right of the first two rows of the calculation, across the head of it.

[136] the right-hand column of the calculation, its first row level with the fourth and fifth rows of the left-hand column. In the row for the antilogarithm of the complement of the latitude, the arc letters "A F" stand after the logarithm, before the degrees; the row for the angle F A K ends with the letters "G P".

Q from A L, the complement of the latitude of the horn, and Q L will result. From it, finally, and the perpendicular F Q, the distance itself of the comet and the upper horn of Taurus will become evident.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the latit. of the comet	A F			60° 57′ 20″	
Compl. of the latit. of the horn	L A			84° 39′ 30″	
Longitude of the horn	♈ R			77° 43′ 42″	
Longitude of the comet	♈ G			50° 10′ 41″	
Difference, or angle	G A R			27° 33′ 1″	
Logarithm	A F	13439			
Log. of the angle	G A R	77106	*A.*		
Log. of the perpendicular	F Q	90545		23° 51′ 0″	

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Line	Arc	Logarithm	Mark	Value	Remark
Antil.	A F	72259			
Antil. of the perpendicular	F Q	8926	*S.*		
Antil.	A Q	63333		57° 56′ 20″	
Compl. of the lat. of the horn	A L			84° 39′ 30″	
	Q L			26° 43′ 10″	
Antil.	Q L	11292			
Antil. of the perpendicular	F Q	8926	*A.*		
Antil. of the distance	F L	20218		35° 13′ 13″	
The observed distance was				35° 15′ 0″	
Difference				1′ 47″	

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It is therefore evident that everything has been carried out accurately. But let us test again whether this also becomes known through the distance of Capella. Accordingly, in the same order as was done before, let first the perpendicular F I be investigated from similar data, then I S, and finally the distance F S itself.

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of the comet	A F			60° 57′ 20″	
Compl. of the lat. of Capella	A S			67° 7′ 45″	
Longitude of the comet	♈ G			50° 10′ 51″	
Longitude of Capella	♈ R			77° 0′ 12″	
Difference, or angle	G A H			26° 49′ 31″	
Logarithm	A F	13439			
Log. of the angle	G A H	79567	*A.*		
Log. of the perpendicular	F I	93006		23° 14′ 12″	

[137] the left-hand column of the check by the distance of the horn of Taurus.
[138] the right-hand column of the check; "Q L" stands alone, with no label.

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Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	A F	72259			
Antil. of the perpendicular	F I	8459	*S.*		
Antil.	I A	63800		58° 6′ 13″	
Compl. of the latit. of Capella	A S			67° 7′ 45″	
	I S			9° 1′ 32″	
Antil.	I S	1246			
Antil. of the perpendicular	F I	8459	*A.*		
Antil. of the distance	F S	9705		24° 50′ 15″	
Observed distance				24° 45′ 0″	
Difference				5′ 15″	

140

Since this distance of Capella was observed somewhat earlier than the others, it certainly cannot agree so precisely with the one derived by calculation, although the comet's proper motion at that time does not run to so many minutes. The chief reason for this small difference, however, is that these observations were made only with the radius, not with the sextant; so a slight error of this kind easily arose. Meanwhile, the calculation of the preceding check has established more than sufficiently that the comet's place was correctly determined.

Observation 18 [Obſervatio 18.]

Given the comet's distances from Palilicium, 37° 57′, and from Capella, 25° 18′ 30″, taken on January 4 at 1^{h} 51^{m} 24^{s}, let the comet's longitude and latitude be sought.

We have already several times found the comet's place from observations of these fixed stars; hence their distance, and also the angle V M S, are already known to us. Therefore in the oblique-angled triangle F M S, with all the sides given, the angle S M F becomes known at once; if V M S, found above, is subtracted from it, the angle F M K will remain. Next, in the right-angled triangle F K M, let the perpendicular F K be investigated from the hypotenuse F M and the said angle F M K; and likewise, with the help of this and F M, the side K M. When K M is taken from A M, the distance of Palilicium from the pole, the side A K will remain. From this in turn, and the remaining side adjacent to the right angle, let A F, the complement of the comet's latitude, be computed in the triangle F K A; and also the angle F A K, or the difference of the longitudes of Aldebaran and the comet, but from the given F K and the hypotenuse A F. When this difference has been subtracted from the longitude of Palilicium, you will have the comet's longitude sought.

[139] the left-hand column of the check by the distance of Capella.

[140] the right-hand column of the check; "I S" stands alone, with no label; in the row for the distance F S an italic ampersand stands between the logarithm and the degrees.

Diagram. An engraved figure in a faint ruled frame, to the right of the upper part of the calculation, for Observation 18. From A at the top arcs, circles of latitude, descend to the ecliptic, which runs across the foot from H to the sign of Aries at its right end: an arc through S to H; an arc through K and V to N, running on below the ecliptic to M; an arc through F to G; and the rightmost through B and C to D. The stars are drawn as asterisks: S, labelled "Capella."; B, under the cursive label "In flex. ad Cox. Ca[[ſſ/ſs]]." (the star in the bend at the hips of Cassiopeia); and M, labelled "Palilicium". The comet is a small circle at F, labelled "Cometa." (the comet). A dotted line runs from K through F to C, and another from S to V. Straight lines join S to F, B to F, S to M and M to F. At the foot, right, stands the engraver's note "Autor Sculpsit" (the author engraved it).

- A (apex): A
- above B: In flex. ad Cox. Ca[[ſſ/ſs]]. (the bend at the hips of Cassiopeia; the last letters, two tall s-forms, not separated)
- B (asterisk): B
- K (left of F, end of the dotted line): K
- F (comet, small circle): F; label "Cometa." (the comet)
- C (right of F, end of the dotted line): C
- S (asterisk): S; label "Capella."
- V (end of the dotted line from S): V
- M (asterisk, below the ecliptic): M; label "Palilicium"
- on the ecliptic, left to right: H, N, G, D, and the sign ♈
- foot, right: Autor Sculpsit (the author engraved it)

Line	Arc	Logarithm	Mark	Value	Remark
Side	S M	67169		30° 43′ 13″	Log.
Side	F M	48618	*A.*	37° 57′ 0″	Log.
Difference		115787		7° 13′ 47″	Aggregate, first
Side	F S			25° 18′ 30″	
Sum				32° 32′ 17″	
Half		127244		16° 16′ 8″	Log.
Difference				18° 4′ 43″	
Half		185080	*A.*	9° 2′ 21″	Log.
Second aggregate		312324			
First aggregate		115787	*S.*		
Remainder		196537			
Half-angle		98268		21° 58′ 53″	
Whole angle	S M F			43° 57′ 46″	
Angle	V M S			22° 7′ 17″	
Angle	F M K			21° 50′ 29″	
Log.	F M	48618			
Log.	F M K	98876	*A.*		
Log. of the perpendicular	F K	147444		13° 13′ 33″	

Line	Arc	Logarithm	Mark	Value	Remark
Antil.	F M	23756			
Antil. of the perpendicular	F K	2688	*S.*		
Antil.	K M	21068		35° 54′ 0″	
Dist. of Palilicium from the pole	A M			95° 29′ 57″	
	A K			59° 35′ 57″	
Antil. of the perpendicular	F K	2688			
Antilog.	A K	68115	*A.*		
Antilog.	A F	70803		60° 29′ 14″	
Latitude of the comet sought				29° 30′ 46″	
Log. of the perpendicular	F K	147444			
Log.	A F	13898	*S.*		
Log.	F A K	133546		15° 15′ 1″	
Longitude of Palilicium	♈ N			64° 57′ 8″	
Longitude of the comet sought				19° 42′ 7″	

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But in making the check by the distance of the comet and the star in the bend at the hips of Cassiopeia, observed at $2^{h}\ 26^{m}\ 54^{s}$, we found first, from the difference of the longitudes of the comet and the star, and also from the complement of the comet's latitude A F, the perpendicular C F. Then, the two sides C F and A F being thus known, the third side A C results; from it let the complement of the latitude of the star be taken, and the side B C will come out. Finally, in the triangle B C F, given the sides about the right angle, the hypotenuse B F also becomes known, namely the distance of the comet and the star sought.

[Margin: Examen calculi.] (Check of the calculation.)

Line	Arc	Logarithm	Mark	Value	Remark
Compl. of the lat. of the comet	A F			60° 29′ 14″	
Compl. of the lat. of the star	A B			41° 13′ 30″	
Longitude of the star	♈ D			39° 11′ 42″	
Longitude of the comet	♈ G			49° 42′ 7″	
Difference, or angle	D A G			10° 30′ 25″	
Logarithm	A F	13898			
Log. of the angle	D A G	170180	*A.*		
Log. of the perpendicular	F C	184078		9° 7′ 52″	

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[141] a single unruled column of calculation to the left of the figure. In the first eight rows the degrees stand to the left of the logarithm, which follows "Log." or "Agg." (in the third row, followed by "prius"); from the row for the perpendicular F K the degrees stand in a column to the right of the logarithms. "A K" stands alone in its row. No zodiac sign follows the comet's longitude.

[142] the left-hand column of the check by the distance of the star in the bend at the hips of Cassiopeia.

Line	Arc	Logarithm	Mark	Value	Remark
Antil.	A F	70803			
Antil. of the perpendicular	F C	1275	*S.*		
Antil.	A C	69528		60° 4′ 15″	
Compl. of the latit. of the star	A B			41° 13′ 30″	
	B C			18° 50′ 45″	
Antil.	C B	5509			
Antil. of the perpendicular	C F	1275	*A.*		
Antil. of the distance	B F	6784		20° 52′ 0″	
The observed distance was				20° 48′ 30″	
Difference				3′ 30″	

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Since this distance of the hips of Cassiopeia was taken about 36^{m} later, the distance found necessarily exceeds the observed interval by about 2′, provided we set out the calculation properly; if you subtract this excess from the difference, a discrepancy of scarcely any moment will remain. We therefore rightly judge that this place of the comet, too, has been correctly determined.

Observation 19 [Obfervatio 19.]

Given the comet's distances from Capella, 25° 46′, and from the bend at the hips of Cassiopeia, 18° 42′, taken on January 7 at 2^{h} 26^{m} 9^{s}, let the comet's longitude and latitude be sought.

Although on this last day of its appearance the comet was observed only with a great deal of labour, both because of passing clouds and because of the smallness of its body and the weakness of its light, we shall nevertheless make the effort to derive its true place from these observations. In the accompanying drawing, then, let F be the comet, S Capella, M the following star of the left foot of Perseus, and B the star in the bend at the hips of Cassiopeia. First, in the right-angled triangle B A E, there are given A B, the complement of the said star, and the angle A, which the difference of the longitudes of the said star and Capella measures; so let B E be sought, and at the same time also A E. When A S, the complement of Capella's latitude, has been taken from this side, E S remains. Second, in the triangle B E S, the two sides about the right angle being thus known, the hypotenuse B S is also given, namely the distance of the hips of Cassiopeia and Capella; and likewise the angle B S A, from B S and B E. Third, in the oblique-angled triangle B F S, let the angle at S be investigated from the three given sides; added to the angle B S A, it makes up the angle F S A. Fourth, in the triangle F A S, since F S and the angle F S A are now known, the perpendicular F L also results; and also the side L S, from the two remaining sides, which is to be taken from A S, the complement of Capella's latitude, so that A L remains. Fifth and last, once F L and A L are known, A F, the complement of the comet's latitude, results in the right-angled triangle F L

143the right-hand column of the check; "B C" stands alone, with no label.

A, and likewise the angle F A S, which is to be subtracted from the longitude of Capella, so that the comet's longitude itself, which is sought, may be had.

Line	Arc	Value
Longitude of Capella	♈ H	77° 0′ 12″
Longitude at the hips	♈ D	39° 11′ 42″
Difference, or angle	D A H	37° 48′ 30″

Line	Arc	Value
Latitude of Capella	H S	22° 52′ 15″
Compl. of the lat.	A S	67° 7′ 45″

Line	Arc	Value
Latitude at the hips	B D	48° 46′ 30″
Compl. of the lat.	A B	41° 13′ 30″

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Line	Arc	Loga-rithm	Mark	Value	Remark
Logarithm	A B	41706			
Log. of the angle	D A H	48936	*A.*		
Log. of the perpendicular	B E	90642		23° 49′ 36″	
Antil.	A B	28480			
Antil. of the perpendicular	B E	8907	*S.*		
Antilog.	A E	19573		34° 41′ 30″	
Compl. of the latit. of Capella	A S			67° 7′ 45″	
	E S			32° 26′ 15″	
Antil.	E S	16962			
Antil. of the perpendicular	B E	8907	*A.*		
Antil. of the distance	B S	25869		39° 27′ 37″	of Capella and the hips
Log. of the perpendicular	B E	90642			
Log.	B S	45327	*S.*		
Log. of the angle	B S A	45315		39° 28′ 0″	
Side	B S	45327		39° 27′ 37″	Log.
Side	F S	83308		25° 46′ 0″	Log.
Difference		128635		13° 41′ 37″	Aggregate, first
Side	F B			18° 42′ 0″	
Sum				32° 23′ 37″	
Half		127677		16° 11′ 48″	Log.

[144] three groups set side by side at the foot of the page, beginning the calculation for Observation 19; in the middle group the arc letters follow the degrees.

Line	Arc	Loga-rithm	Mark	Value	Remark
Difference				5° 0′ 23″	
Half		313103		2° 30′ 11″	Log.
Second aggregate		440780			
First aggregate		128635			
Remainder		312145			

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Line	Arc	Logarithm	Mark	Value	Remark
Half		156072		12° 7′ 17″	
Whole angle	F S B			24° 14′ 34″	
Angle	B S A			39° 28′ 0″	
Angle	F S A			63° 42′ 34″	
Log.	F S	83308			
Log. of the angle	F S A	10934	*A.*		
Log. of the perpendicular	F L	94242		22° 56′ 5″	
Antil.	F S	10473			
Antil. of the perpendicular	F L	8235	*S.*		
Antil.	L S	2238		12° 4′ 40″	
Compl. of the latitude of Capella	A S			67° 7′ 45″	
	A L			55° 3′ 5″	
Antil. of the perpendicular	F L	8235			
Antil.	A L	55714	*A.*		
Antil. of the compl.	A F	63949		58° 9′ 34″	
Latitude of the comet sought				31° 50′ 26″	
Log. of the perpendicular	F L	94242			
Log.	A F	16309	*S.*		
Log.	F A S	77933		27° 18′ 16″	
Longitude of Capella				77° 0′ 12″	
Longitude of the comet				19° 41′ 56″ ♉	

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Check of the true place of the comet by its distance from the following star of the left foot of Perseus, 22° 0′, observed at 2^h 26^m 9^s.

First let the perpendicular F K be derived by the same method as we have been accustomed to use, and likewise K M; then from K M and F K the distance sought, of the comet and the following star of the foot of Perseus.

[145] the left-hand column of the calculation. In the row for the distance B S, "Cap." stands between the logarithm and the degrees and "& Cox." after them, so that the label reads "distance B S of Capella and the hips". In the rows for the sides and the halves the degrees stand to the left and the logarithm, after "Log." or "Agg.", to the right; in the first "Difference" row, after "Agg." and followed by "prius".

[146] the right-hand column of the calculation; "A L" stands alone, with no label.

Line	Arc	Logarithm	Mark	Value	Re-mark
Compl. of the latit. of the comet	A F			58° 9′ 34″	
Compl. of the lat. of the foot of Perseus	A M			78° 42′ 0″	
Longitude of the comet	♈ G			49° 41′ 56″	
Longitude of the foot of Perseus	♈ N			58° 20′ 12″	
Difference, or angle	G A N			8° 38′ 16″	
Log.	A F	16309			
Log. of the angle	G A N	189638	*A.*		
Log. of the perpendicular	F K	205947		7° 19′ 35″	
Antil.	A F	63949			
Antil. of the perpendicular	F K	820	*S.*		
Antil.	A K	63129		57° 51′ 55″	
Compl. of the latit. of the foot of Perseus	A M			78° 42′ 0″	
	K M			20° 51′ 5″	
Antil.	K M	6773			
Antil. of the perpendicular	F K	820	*A.*		
Antil. of the distance	F M	7593		22° 2′ 35″	
Observed distance				22° 0′ 0″	
Difference				2′ 35″	

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Diagram. An engraved figure in a faint ruled frame, to the right of the check, for Observation 19. From A at the top arcs, circles of latitude, descend to the ecliptic, which runs across the foot from I to the sign of Aries at its right end: two arcs on the left, close together, ending at I and H, the outer passing P, the inner L and the star s; an arc through M to N; an arc through F to G; and the rightmost through B and C to D. A star labelled "Polaris" (the Pole Star), with O beside it, and the letter E stand on the upper part of the left-hand arcs. The stars are drawn as asterisks: Polaris; B, under the cursive label "In flex. ad cox. Caſ." (in the bend at the hips of Cassiopeia); s, labelled "Capella"; and M, labelled "Sin. pes Persei" (the left foot of Perseus). The comet is a small circle at F, labelled "Cometa" (the comet). Dotted lines run from E to B, from P and from L towards F, and from F to C; a short dotted line runs from the arc through M to F. Straight lines join Polaris to F, s to B, s to F, B to F and M to F. At the foot, right, stands the engraver's note "Autor Sculpsit." (the author engraved it).

- A (apex): A
- upper left, at the left-hand arcs: Polaris (the Pole Star), with O beside it
- E (left-hand arc, end of the dotted line to B): E
- above B: In flex. ad cox. Caſ. (in the bend at the hips of Cassiopeia)
- B (asterisk): B

[147] the check stands below the caption, to the left of the figure; "K M" stands alone, with no label.

- P (outer left-hand arc): P
- L (inner left-hand arc): L
- C (rightmost arc, end of the dotted line from F): C
- F (comet, small circle): F; label "Cometa" (the comet)
- s (asterisk, a small lower-case letter): s; label "Capella"
- M (asterisk): M; label "Sin. pes Persei" (the left foot of Perseus)
- on the ecliptic, left to right: I, H, N, G, D, and the sign ♈
- foot, right: Autor Sculpsit. (the author engraved it)

This time too, then, the comet's place has been derived accurately enough. But let us test the truth of the matter in yet another way, namely by the distance of the Pole Star, 39° 45′, taken at 2^h 53^m 29^s. The perpendicular F P must be investigated, then O P; and so the distance itself of the comet and the Pole Star, F O, which was to be investigated, will become evident from the two given sides O P and F P.

Line	Arc	Logarithm	Mark	Value	Re-mark
Compl. of the latit. of the Pole Star	A O			23° 58′ 0″	
Compl. of the latit. of the comet	A F			58° 9′ 34″	
Longitude of the comet	♈ G			49° 41′ 56″	
Longitude of the Pole Star	♈ I			83° 46′ 42″	
Difference, or angle	G A I			34° 4′ 46″	
Log.	A F	16309			
Log. of the angle	G A I	57922	*A.*		
Log. of the perpendicular	F P	74231		28° 25′ 31″	

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Line	Arc	Logarithm	Mark	Value	Remark
Antil.	A F	63949			
Antil. of the perpendicular	F P	12848	*S.*		
Antil.	A P	51101		53° 8′ 19″	
Compl. of the latit. of the Pole Star	A O			23° 58′ 0″	
	O P			29° 10′ 19″	
Antil.	O P	13564			
Antil. of the perpendicular	F P	12848	*A.*		
Antil. of the distance	F O	26412		39° 50′ 10″	
Observed distance				39° 45′ 0″	
Difference				5′ 10″	

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[148] the left-hand column of the check by the distance of the Pole Star; a short broken vertical stroke stands after the seconds of the comet's longitude.

[149] the right-hand column of the check; "O P" stands alone, with no label, and the arc letters "A O" and "O P" stand in the logarithm column.

I am indeed surprised that this distance as found does not depart further from the observed one, since so large a distance was taken only with the smaller radius, and the sky, moreover, was so cloudy that it was scarcely possible to carry out this observation as one wished at that time.

Section VI. To Find the Latitudes and Longitudes from the Comet's Declinations and Right Ascensions [SECTIO VI. Ex Cometæ Declinationibus,& Aſcenſionibus Rectis inveſtigare Latitudines, & Longitudines.]

In the preceding section we investigated with the greatest diligence the comet's true longitudes and latitudes from all those observed distances of the comet and the fixed stars, wherever this could conveniently be done. It follows that we now also go on to investigate the same true position of the comet, with respect to the ecliptic, from all the remaining observations, which depend on the comet's altitudes and azimuths. To carry out this business duly, we are given its declinations and right ascensions, already found in Sect. IV; with their help the longitudes and latitudes are computed by the following method. The reckoning of the calculation, in the attached diagrams, is this. In them let the circle A E ♋ B etc. be the solstitial colure [colurus Solſtitiorum]; A ♈ B the equator, whose pole is E; ♎ ♈ ♋ the ecliptic, whose pole is D; E C G the circle of declination, showing the comet's declination G C; D C F the circle of latitude, showing the latitude F C and the longitude from the beginning of Aries, ♈ F; and C the comet. From C let the arc of a great circle C ♈ be drawn, so that two triangles arise with a common hypotenuse, C ♈ G and C ♈ F, right-angled at F and G.

[Margin: Ratio calculi pro inveniendis latitudinibus & longitudinibus ex declin. & Aſc. R.] (Method of calculation for finding the latitudes and longitudes from the declinations and right ascensions.)

First, then, the triangle C ♈ G is to be solved. In it, given the declination G C and the right ascension ♈ G, namely the two sides enclosing the right angle, let the hypotenuse ♈ C be investigated: the sum, that is, of the antilogarithms of ♈ G and G C is the antilogarithm of the hypotenuse. Then in the same triangle let the angle G ♈ C be sought, from the hypotenuse ♈ C and the declina- tion C G: namely, the logarithm of the hypotenuse subtracted from the logarithm of the declination leaves the logarithm of the angle sought. This angle and the obliquity of the ecliptic are to be subtracted from each other if the declination is northern in a northern sign, or southern in a southern sign; but if it is northern in a southern sign, or southern in a northern sign, they are to be added. The sum or the remainder will be the angle C ♈ F.

Diagram. Three engraved circle diagrams set side by side across the measure, between the first and second paragraphs of the page. In each circle the equator, labelled "Æquator.", runs across from B on the left to A on the right, passing through the sign of Aries near the centre; the ecliptic, labelled "Ecliptica.", runs from the sign of Cancer on the left through the sign of Aries to the sign of Capricorn on the right; the comet C is drawn as an asterisk, and a dotted line

joins C to the sign of Aries. Where the left circle meets the middle one, and the middle meets the right, the letters are printed together as "AB". In the left circle C stands below the equator, and two arcs run from D and E at the foot of the circle through C up to G on the equator and F on the ecliptic. In the middle circle E stands at the top and D at the foot; C stands just above the equator, with F above it on the ecliptic and G below it on the equator. In the right circle E and D stand at the top; C stands high in the circle, above the ecliptic, with F on the ecliptic and G on the equator below it. Below the right circle stands the engraver's note "Autor Sculpsit." (the author engraved it).

- left circle: ♋ (upper left, end of the ecliptic); B (left, end of the equator); F (on the ecliptic); G (on the equator); ♈ (centre); "Æquator." (the equator); C (asterisk, below the equator); "Ecliptica." (the ecliptic); D and E (foot of the circle); ♍ (right, end of the ecliptic)
- between the left and middle circles: AB
- middle circle: E (top); ♋ (left); F; C (asterisk); ♈; "Æquator."; G; "Ecliptica."; ♍ (right); D (foot)
- between the middle and right circles: AB
- right circle: E and D (top); C (asterisk); ♋ (left); F; G; ♈; "Æquator."; A (right, end of the equator); "Ecliptica."; ♍ (right)
- below the right circle: Autor Sculpsit. (the author engraved it)

Now in the triangle C ♈ F, with the hypotenuse and the angle just found known, the latitude C F is found as follows: the sum of the logarithms of C ♈ and of the angle C ♈ F is the logarithm of the latitude. At the same time, in the same triangle, since the two sides, the hypotenuse ♈ C and the latitude C F, are known, the third side ♈ F also results, the longitude of the comet: if, that is, you subtract the antilogarithm of the latitude from the antilogarithm of the hypotenuse ♈ C, you will have the antilogarithm of the longitude ♈ F sought. All the following longitudes and latitudes have been computed by this method. The calculation does not, however, always use the same diagram; sometimes a quite different one is needed, especially when the declination is southern, or northern and at the same time greater than the obliquity of the ecliptic, though the demonstration always remains the same. This will be clear from the calculation of the sixth and the following observations. Let us now set out in order the calculation itself of all those observations from which the longitude and latitude had to be investigated.

Observation 1 [Observatio 1.]

Calculation of the longitude and latitude for the year 1652, December 23, at $7^h\ 22^m\ 7^s$, given the declination 17° 2′ 26″ N. and the right ascension 57° 23′ 30″.

Line	Arc	Logarithm	Mark	Value	Remark
Antilog. of the declin.	G C	4490			
Antilog. of the right asc.	♈ G	61824	*A.*		

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the hyp.	♈ C	66314		58° 59′ 14″	
Log. of the declin.	G C	122741			
Log. of the hyp.	♈ C	15434	*S.*		
Log. of the angle	G ♈ C	107307		19° 59′ 47″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			3° 30′ 29″	
Log. of the hyp.	♈ C	15434			
Log. of the angle	C ♈ F	279379	*A.*		
Log. of the latit.	F C	294813		3° 0′ 21″	Latitude sought
Antil. of the hyp.	♈ C	66314			
Antil. of the latit.	C F	137	*S.*		
Antil. of the long.	♈ F	66177		58° 56′ 24″	Longitude sought

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Observation 2 [Obſervatio 2.]

On December 23, at 10^{h} 57^{m} 20^{s}, given the declination 18° 18′ 51″ N. and the right ascension 57° 11′ 27″.

Line	Arc	Logarithm	Mark	Value	Remark
Antilog.	G C	5198			
Antilog. of the right asc.	♈ G	61280	*A.*		
Antil. of the hyp.	♈ C	66478		59° 2′ 38″	
Log. of the declin.	G C	115763			
Log. of the hyp.	♈ C	15366	*S.*		
Log. of the angle	G ♈ C	100397		21° 29′ 43″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			2° 0′ 33″	
Log. of the hyp.	♈ C	15366			
Log. of the angle	C ♈ F	335069	*A.*		
Long. lat.	F C	350435		1° 43′ 23″	Latitude of the comet
Antil. of the hyp.	♈ C	66478			
Antil. of the lat.	C F	45	*S.*		
Antil. of the long.	♈ F	66433		59° 1′ 41″	Longitude of the comet

[150] the calculation for Observation 1 stands in the left half of the page, under its heading and caption. In the last two rows "Latit." and "Long." stand before the degrees and "quæs." after them.

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Observation 3 [Obſervatio 3.]

On December 23, at 11^{h} 28^{m}, given the declination 18° 28′ 3″ N. and the right ascension 56° 54′ 53″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	5286			
Antil. of the right asc.	♈ G	60532	*A.*		
Antil. of the hyp.	♈ C	65818		58° 48′ 56″	
Log. of the declin.	G C	114957			
Log. of the hyp.	♈ C	15606	*S.*		
Log. of the angle	G ♈ C	99351		21° 43′ 58″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			1° 46′ 18″	
Log. of the hyp.	♈ C	15606			
Log. of the angle	C ♈ F	347648	*A.*		
Log. of the latit.	F C	363254		1° 30′ 56″	Latitude of the comet
Antil. of the hyp.	♈ C	65818			
Antil. of the lat.	C F	35	*S.*		
Antil. of the long.	♈ F	65783		58° 48′ 13″	Longitude of the comet

Observation 4 [Obſervatio 4.]

On December 24, at 1^{h} 27^{m} 30^{s}, given the declination 19° 0′ 28″ N. and the right ascension 56° 45′ 14″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	5607			
Antil. of the right asc.	♈ G	60104	*A.*		
Antil. of the hyp.	♈ C	65711		58° 46′ 41″	
Log. of the declin.	G C	112179			
Log. of the hyp.	♈ C	15645	*S.*		
Log. of the angle	G ♈ C	96534		22° 23′ 12″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			1° 7′ 4″	
Log. of the hyp.	♈ C	15645			

[151] the calculation for Observation 2 stands in the right half of the page. In the last rows "Latit." and "Long." stand before the degrees and "Com." after them. The label of the latitude row is printed "Long. lat." where the left-hand calculation prints "Log. latit."; it is kept as printed. In the last row the second figure of the degrees is covered by a blot of ink; it is read as 9 by its outline.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the angle	C ♈ F	393695	*A.*		
Log. of the latit.	F C	409340		0° 57′ 21″	Latitude of the comet
Antil. of the hyp.	♈ C	65711			
Antil. of the lat.	C F	14	*S.*		
Antil. of the long.	♈ F	65697		58° 46′ 25″	Longitude of the comet

Observation 5 [Obſervatio 5.]

On December 24, at 1^{h} 44^{m} 15^{s}, given the declination 19° 15′ 13″ N. and the right ascension 55° 49′ 42″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	5755			
Antil. of the right asc.	♈ G	57682	*A.*		
Antil. of the hyp.	♈ C	63437		57° 58′ 34″	
Log. of the declin.	G C	110942			
Log. of the hyp.	♈ C	16508	*S.*		
Log. of the angle	G ♈ C	94434		22° 53′ 18″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			36′ 58″	
Log. of the hyp.	♈ C	16508			
Log. of the angle	C ♈ F	453257	*A.*		
Log. of the latit.	F C	469765		0° 31′ 20″	Latitude of the comet
Antil. of the hyp.	♈ C	63437			
Antil. of the latit.	C F	4	*S.*		
Antil. of the long.	♈ F	63433		57° 58′ 29″	Longitude of the comet

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Observation 6 [Obſervatio 6.]

On December 26, at 11^{h} 38^{m} 22^{s}, given the declination 32° 11′ 35″ N. and the right ascension 48° 16′ 9″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	16692			
Antil. of the right asc.	♈ G	40701	*A.*		
Antil. of the hyp.	♈ C	57393		55° 42′ 56″	
Log. of the declin.	G C	62968			
Log. of the hyp.	♈ C	19087	*S.*		

[152] the angle C ♈ F has no figure in the degree column; it is given as printed, in minutes and seconds.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the angle	G ♈ C	43881		40° 9′ 3″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			16° 38′ 47″	
Log. of the hyp.	♈ C	19087			
Log. of the angle	C ♈ F	125015	*A.*		
Log. of the latit.	F C	144102		13° 41′ 27″	Latitude of the comet
Antil. of the hyp.	♈ C	57393			
Antil. of the latit.	C F	2882	*S.*		
Antil. of the long.	♈ F	54511		54° 33′ 53″	Longitude of the comet

Observation 7 [Obſervatio 7.]

On December 26, at 11^{h} 44^{m} 48^{s}, given the declination 32° 10′ 11″ N. and the right ascension 48° 6′ 26″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	16663			
Antil. of the right asc.	♈ G	40385	*A.*		
Antil. of the hyp.	♈ C	57048		55° 34′ 49″	
Log. of the declin.	G C	63039			
Log. of the hyp.	♈ C	19248	*S.*		
Log. of the angle	G ♈ C	43791		40° 11′ 39″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			16° 41′ 23″	
Log. of the hyp.	♈ C	19248			
Log. of the angle	C ♈ F	124762	*A.*		
Long.latit.	F C	144010		13° 42′ 14″	Latitude of the comet
Antil. of the hyp.	♈ C	57048			
Antil. of the lat.	C F	2888	*S.*		
Antil. of the long.	♈ F	54160		54° 25′ 17″	Longitude of the comet

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Observation 8 [Obſervatio 8.]

On December 26, at 11^{h} 50^{m} 31^{s}, given the declination 32° 13′ 47″ N. and the right ascension 47° 54′ 23″.

[153] the label of the latitude row is printed "Long.latit." where the other calculations print "Log. latit."; it is kept as printed.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	16733			
Antil. of the right asc.	♈ G	39996	*A.*		
Antil. of the hyp.	♈ C	56729		55° 27′ 17″	
Log. of the declin.	G C	62862			
Log. of the hyp.	♈ C	19398	*S.*		
Log. of the angle	G ♈ C	43464		40° 21′ 12″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			16° 50′ 56″	
Log. of the hyp.	♈ C	19398			
Log. of the angle	C ♈ F	123839	*A.*		
Log. of the latit.	F C	143237		13° 48′ 43″	Latitude of the comet
Antil. of the hyp.	♈ C	56729			
Antil. of the latit.	C F	2934	*S.*		
Antil. of the long.	♈ F	53795		54° 16′ 17″	Longitude of the comet

Observation 9 [Obſervatio 9.]

On December 27, at 12^{h} 48^{m} 15^{s}, given the declination 32° 10′ 40″ N. and the right ascension 48° 24′ 25″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	16676			
Antil. of the right asc.	♈ G	40970	*A.*		
Antil. of the hyp.	♈ C	57646		55° 48′ 51″	
Log. of the declin.	G C	63005			
Log. of the hyp.	♈ C	18970	*S.*		
Log. of the angle	G ♈ C	44035		40° 4′ 35″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			16° 34′ 19″	
Log. of the hyp.	♈ C	18970			
Log. of the angle	C ♈ F	125451	*A.*		
Log. of the lat.	F C	144421		13° 38′ 48″	Latitude of the comet
Antil. of the hyp.	♈ C	57646			
Antil. of the lat.	C F	2864	*S.*		
Antil. of the long.	♈ F	54782		54° 40′ 30″	Longitude of the comet

Observation 10 [Obſervatio 10.]

On December 27, at 12^{h} 55^{m} 15^{s}, given the declination 32° 33′ 22″ N. and the right ascension 47° 36′ 35″.

Line	Arc	Logarithm	Mark	Value	Remark
Antilog. of the declin.	G C	17095			
Antilog. of the right asc.	♈ G	39426	*A.*		
Antil. of the hyp.	♈ C	56521		55° 22′ 20″	
Log. of the declin.	G C	61965			
Log. of the hyp.	♈ C	19497	*S.*		
Log. of the angle	G ♈ C	42468		40° 50′ 30″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			17° 20′ 14″	
Log. of the hyp.	♈ C	19497			
Log. of the angle	C ♈ F	121067	*A.*		
Log. of the latit.	F C	140564		14° 11′ 39″	Latitude of the comet
Antil. of the hyp.	♈ C	56521			
Antil. of the latit.	C F	3101	*S.*		
Antil. of the long.	♈ F	53420		54° 7′ 0″	Longitude of the comet

Observation 11 [Obſervatio 11.]

On December 27, at 1^{h} 24^{m} 45^{s}, given the declination 33° 2′ 53″ N. and the right ascension 47° 30′ 16″.

Line	Arc	Logarithm	Mark	Value	Remark
Antilog. of the declin.	G C	17647			
Antilog. of the right asc.	♈ G	39225	*A.*		
Antil. of the hyp.	♈ C	56872		55° 30′ 40″	
Log. of the declin.	G C	60637			
Log. of the hyp.	♈ C	19331	*S.*		
Log. of the angle	G ♈ C	41306		41° 25′ 25″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			17° 55′ 9″	
Log. of the hyp.	♈ C	19331			
Log. of the angle	C ♈ F	117872	*A.*		
Log. of the lat.	F C	137203		14° 41′ 24″	Latitude of the comet
Antil. of the hyp.	♈ C	56872			
Antil. of the lat.	C F	3323	*S.*		
Antil. of the long.	♈ F	53549		54° 10′ 12″	Longitude of the comet

Observation 12 [Obſervatio 12.]

On December 27, at 5^{h} 14^{m} 5^{s}, given the declination 34° 4′ 34″ N. and the right ascension 46° 2′ 20″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	18839			
Antil. of the right asc.	♈ G	36504	*A.*		
Antil. of the hyp.	♈ C	55343		54° 54′ 7″	
Log. of the declin.	G C	57930			
Log. of the hyp.	♈ C	20069	*S.*		
Log. of the angle	G ♈ C	37861		43° 13′ 16″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			19° 43′ 0″	
Log. of the hyp.	♈ C	20069			
Log. of the angle	C ♈ F	108658	*A.*		
Log. of the latit.	F C	128727		16° 1′ 22″	Latitude of the comet
Antil. of the hyp.	♈ C	55343			
Antil. of the lat.	C F	3962	*S.*		
Antil. of the long.	♈ F	51381		53° 15′ 27″	Longitude of the comet

Observation 13 [Obſervatio 13.]

On December 27, at 5^{h} 19^{m} 1^{s}, given the declination 34° 11′ 11″ N. and the right ascension 46° 23′ 32″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	18968			
Antil. of the right asc.	♈ G	37147	*A.*		
Antil. of the hyp.	♈ C	56115		55° 12′ 40″	
Log. of the declin.	G C	57654			
Log. of the hyp.	♈ C	19693	*S.*		
Log. of the angle	G ♈ C	37961		43° 10′ 2″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			19° 39′ 46″	
Log. of the hyp.	♈ C	19693			
Log. of the angle	C ♈ F	108919	*S.*		
Log. of the lat.	F C	128612		16° 2′ 31″	Latitude of the comet
Antil. of the hyp.	♈ C	56115			
Antil. of the lat.	C F	3972	*A.*		
Antil. of the long.	♈ F	52143		53° 34′ 51″	Longitude of the comet

[154] in this calculation the page marks the logarithm of the angle C ♈ F "S." and the antilogarithm of the latitude "A.", the reverse of the other calculations; the figures are added and subtracted as in the others. Both marks are given as printed.

Observation 14 [Obſervatio 14.]

On December 27, at 5^h 23^m 58^s, given the declination 34° 23′ 14″ N. and the right ascension 46° 24′ 41″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	19207			
Antil. of the right asc.	♈ G	37181	*A.*		
Antil. of the hyp.	♈ C	56388		55° 19′ 11″	
Log. of the declin.	G C	57131			
Log. of the hyp.	♈ C	19561	*S.*		
Log. of the angle	G ♈ C	37570		43° 22′ 42″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			19° 52′ 6″	
Log. of the hyp.	♈ C	19561			
Log. of the angle	C ♈ F	107922	*A.*		
Log. of the lat.	F C	127483		16° 13′ 43″	Latitude of the comet
Antil. of the hyp.	♈ C	56388			
Antil. of the lat.	C F	4066	*S.*		
Antil. of the long.	♈ F	52322		53° 39′ 26″	Longitude of the comet

Observation 15 [Obſervatio 15.]

On December 27, at 5^h 33^m 39^s, given the declination 34° 20′ 24″ N. and the right ascension 46° 48′ 53″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	19151			
Antil. of the right asc.	♈ G	37926	*A.*		
Antil. of the hyp.	♈ C	57077		55° 35′ 30″	
Log. of the declin.	G C	57252			
Log. of the hyp.	♈ C	19233	*S.*		
Log. of the angle	G ♈ C	38019		43° 8′ 10″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			19° 37′ 54″	
Log. of the hyp.	♈ C	19233			
Log. of the angle	C ♈ F	109070	*A.*		
Log. of the latit.	F C	128303		16° 5′ 34″	Latitude of the comet
Antil. of the hyp.	♈ C	57077			
Antil. of the lat.	C F	3997	*S.*		
Antil. of the long.	♈ F	53080		53° 58′ 30″	Longitude of the comet

Observation 16 [Obſervatio 16.]

On December 27, at 5^h 40^m 48^s, given the declination 34° 25′ 11″ N. and the right ascension 46° 39′ 42″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	19246			
Antil. of the right asc.	♈ G	37643	*A.*		
Antil. of the hyp.	♈ C	56889		55° 31′ 3″	
Log. of the declin.	G C	57044			
Log. of the hyp.	♈ C	19322	*S.*		
Log. of the angle	G ♈ C	37722		43° 17′ 46″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			19° 47′ 30″	
Log. of the hyp.	♈ C	19322			
Log. of the angle	C ♈ F	108292	*A.*		
Log. of the latit.	F C	127614		16° 12′ 25″	Latitude of the comet
Antil. of the hyp.	♈ C	56889			
Antil. of the lat.	C F	4055	*S.*		
Antil. of the long.	♈ F	52834		53° 52′ 20″	Longitude of the comet

Observation 17 [Obſervatio 17.]

On December 27, at 5^h 50^m 9^s, given the declination 34° 27′ 56″ N. and the right ascension 46° 17′ 14″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	19300			
Antil. of the right asc.	♈ G	36955	*A.*		
Antil. of the hyp.	♈ C	56255		55° 16′ 1″	
Log. of the declin.	G C	56889			
Log. of the hyp.	♈ C	19624	*S.*		
Log. of the angle	G ♈ C	37265		43° 32′ 38″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			20° 2′ 12″	
Log. of the hyp.	♈ C	19624			
Log. of the angle	C ♈ F	107112	*A.*		
Log. of the latit.	F C	126737		16° 21′ 14″	Latitude of the comet
Antil. of the hyp.	♈ C	56255			
Antil. of the latit.	C F	4130	*S.*		
Antil. of the long.	♈ F	52125		53° 34′ 26″	Longitude of the comet

Observation 18 [Obſervatio 18.]

On December 27, at 11^{h} 44^{m} 31^{s}, given the declination 35° 8′ 36″ N. and the right ascension 45° 48′ 34″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	20123			
Antil. of the right asc.	♈ G	36090	*A.*		
Antil. of the hyp.	♈ C	56213		55° 15′ 1″	
Log. of the declin.	G C	55230			
Log. of the hyp.	♈ C	19644	*S.*		
Log. of the angle	G ♈ C	35586		44° 28′ 22″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			20° 58′ 6″	
Log. of the hyp.	♈ C	19644			
Log. of the angle	C ♈ F	102763	*A.*		
Log. of the latit.	F C	122407		17° 5′ 57″	Latitude of the comet
Antil. of the hyp.	♈ C	56213			
Antil. of the latit.	C F	4521	*S.*		
Antil. of the long.	♈ F	51692		53° 23′ 24″	Longitude of the comet

Observation 19 [Obſervatio 19.]

On December 27, at 11^{h} 52^{m} 31^{s}, given the declination 35° 1′ 33″ N. and the right ascension 45° 39′ 13″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	19980			
Antil. of the right asc.	♈ G	35811	*A.*		
Antil. of the hyp.	♈ C	55791		55° 4′ 54″	
Log. of the declin.	G C	55520			
Log. of the hyp.	♈ C	19851	*S.*		
Log. of the angle	G ♈ C	35669		44° 25′ 34″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			20° 55′ 18″	
Log. of the hyp.	♈ C	19851			
Log. of the angle	C ♈ F	102976	*A.*		
Long.latit.	F C	122827		17° 1′ 32″	Latitude of the comet
Antil. of the hyp.	♈ C	55791			
Antil. of the lat.	C F	4482	*S.*		
Antil. of the long.	♈ F	51309		53° 13′ 36″	Longitude of the comet

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Observation 20 [Obſervatio 20.]

On December 28, at 12^h 13^m 46^s, given the declination 35° 5′ 50″ N. and the right ascension 45° 38′ 35″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	20065			
Antil. of the right asc.	♈ G	25793	*A.*		
Antil. of the hyp.	♈ C	55858		55° 6′ 31″	
Log. of the declin.	G C	55334			
Log. of the hyp.	♈ C	19818	*S.*		
Log. of the angle	G ♈ C	35516		44° 30′ 42″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			21° 0′ 26″	
Log. of the hyp.	♈ C	19818			
Log. of the angle	C ♈ F	102575	*A.*		
Log. of the latit.	F C	122393		17° 6′ 7″	Latitude of the comet
Antil. of the hyp.	♈ C	55858			
Antil. of the latit.	C F	4522	*S.*		
Antil. of the long.	♈ F	51336		53° 14′ 19″	Longitude of the comet

Observation 21 [Obſervatio 21.]

On December 29, at 3^h 50^m 52^s, given the declination 37° 44′ 37″ N. and the right ascension 42° 40′ 10″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	23477			
Antil. of the right asc.	♈ G	30748	*A.*		
Antil. of the hyp.	♈ C	54225		54° 26′ 51″	
Log. of the declin.	G C	49082			
Log. of the hyp.	♈ C	20633	*S.*		
Log. of the angle	G ♈ C	28449		48° 47′ 57″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			25° 17′ 41″	
Log. of the hyp.	♈ C	20633			
Log. of the angle	C ♈ F	85034	*A.*		
Log. of the lat.	F C	105667		20° 20′ 28″	Latitude of the comet

[155] the label of the latitude row is printed "Long.latit." where the other calculations print "Log.latit."; it is kept as printed.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the hyp.	♈ C	54225			
Antil. of the lat.	C F	6439	*S.*		
Antil. of the long.	♈ F	47786		51° 40′ 33″	Longitude of the comet

Observation 22 [Obſervatio 22.]

On December 29, at 3^{h} 55^{m} 52^{s}, given the declination 37° 33′ 41″ N. and the right ascension 42° 26′ 26″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	23232			
Antil. of the right asc.	♈ G	30383	*A.*		
Antil. of the hyp.	♈ C	53615		54° 11′ 49″	
Log. of the declin.	G C	49494			
Log. of the hyp.	♈ C	20947	*S.*		
Log. of the angle	G ♈ C	28547		48° 44′ 5″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			25° 13′ 49″	
Log. of the hyp.	♈ C	20947			
Log. of the angle	C ♈ F	85273	*A.*		
Log. of the lat.	F C	106220		20° 13′ 28″	Latitude of the comet
Antil. of the hyp.	♈ C	53615			
Antil. of the lat.	C F	6364	*S.*		
Antil. of the long.	♈ F	47251		51° 25′ 58″	Longitude of the comet

Observation 23 [Obſervatio 23.]

On December 29, at 4^{h} 28^{m} 50^{s}, given the declination 37° 12′ 8″ N. and the right ascension 44° 27′ 52″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	22752			
Antil. of the right asc.	♈ G	33733	*A.*		
Antil. of the hyp.	♈ C	56485		55° 21′ 30″	
Log. of the declin.	G C	50314			
Log. of the hyp.	♈ C	19515	*S.*		
Log. of the angle	G ♈ C	30799		47° 18′ 3″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			23° 47′ 47″	
Log. of the hyp.	♈ C	19515			
Log. of the angle	C ♈ F	90761	*A.*		

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the lat.	F C	110276		19° 23′ 14″	Latitude of the comet
Antil. of the hyp.	♈ C	56485			
Antil. of the lat.	C F	5837	*S.*		
Antil. of the long.	♈ F	50648		52° 56′ 37″	Longitude of the comet

Observation 24 [Obſervatio 24.]

On December 29, at 4^{h} 47^{m} 49^{s}, given the declination 37° 28′ 45″ N. and the right ascension 42° 31′ 3″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	23122			
Antil. of the right asc.	♈ G	30507	*A.*		
Antil. of the hyp.	♈ C	53629		54° 12′ 3″	
Log. of the declin.	G C	49682			
Log. of the hyp.	♈ C	20940	*S.*		
Log. of the angle	G ♈ C	28742		48° 36′ 28″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			25° 6′ 12″	
Log. of the hyp.	♈ C	20940			
Log. of the angle	C ♈ F	85743	*A.*		
Log. of the latit.	F C	106683		20° 7′ 37″	Latitude of the comet
Antil. of the hyp.	♈ C	53629			
Antil. of the latit.	C F	6301	*S.*		
Antil. of the long.	♈ F	47328		51° 28′ 3″	Longitude of the comet

Observation 25 [Obſervatio 25.]

On December 31, at 3^{h} 37^{m} 26^{s}, given the declination 41° 3′ 7″ N. and the right ascension 40° 39′ 35″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	28221			
Antil. of the right asc.	♈ G	27628	*A.*		
Antil. of the hyp.	♈ C	55849		55° 6′ 19″	
Log. of the declin.	G C	42046			
Log. of the hyp.	♈ C	19821	*S.*		
Log. of the angle	G ♈ C	22225		53° 11′ 50″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			29° 41′ 34″	
Log. of the hyp.	♈ C	19821			

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the angle	C ♈ F	70248	*A.*		
Long.latit.	F C	90069		23° 58′ 19″	Latitude of the comet
Antil. of the hyp.	♈ C	55849			
Antil. of the lat.	C F	9020	*S.*		
Antil. of the long.	♈ F	46829		51° 14′ 22″	Longitude of the comet

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Observation 26 [Obſervatio 26.]

On December 31, at 3^{h} 44^{m} 24^{s}, given the declination 40° 55′ 28″ N. and the right ascension 40° 48′ 49″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	28027			
Antil. of the right asc.	♈ G	27860	*A.*		
Antil. of the hyp.	♈ C	55887		55° 7′ 13″	
Log. of the declin.	G C	42301			
Log. of the hyp.	♈ C	19802	*S.*		
Log. of the angle	G ♈ C	22499		52° 59′ 20″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			29° 29′ 4″	
Log. of the hyp.	♈ C	19802			
Log. of the angle	C ♈ F	70889	*A.*		
Log. of the latit.	F C	90691		23° 48′ 51″	Latitude of the comet
Antil. of the hyp.	♈ C	55887			
Antil. of the latit.	C F	8897	*S.*		
Antil. of the long.	♈ F	46990		51° 18′ 48″	Longitude of the comet

Observation 27 [Obſervatio 27.]

On December 31, at 4^{h} 27^{m} 22^{s}, given the declination 41° 17′ 20″ N. and the right ascension 40° 19′ 35″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	28582.			
Antil. of the right asc.	♈ G	27132	*A.*		
Antil. of the hyp.	♈ C	55714		55° 3′ 4″	
Log. of the declin.	G C	41572			
Log. of the hyp.	♈ C	19886	*S.*		

[156] the label of the latitude row is printed "Long.latit." where the other calculations print "Log.latit."; it is kept as printed.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the angle	G ♈ C	21686		53° 36′ 45″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			30° 6′ 29″	
Log. of the hyp.	♈ C	19886			
Log. of the angle	C ♈ F	68990	*A.*		
Log. of the lat.	F C	88876		24° 16′ 40″	Latitude of the comet
Antil. of the hyp.	♈ C	55714			
Antil. of the lat.	C F	9259	*S.*		
Antil. of the long.	♈ F	46455		51° 4′ 0″	Longitude of the comet

Observation 28 [Obſervatio 28.]

On January 1, 1653, at 2^{h} 15^{m} 40^{s}, given the declination 42° 32′ 52″ N. and the right ascension 39° 55′ 35″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	30553			
Antil. of the right asc.	♈ G	26544	*A.*		
Antil. of the hyp.	♈ C	57097		55° 35′ 59″	
Log. of the declin.	G C	39178			
Log. of the hyp.	♈ C	19223	*S.*		
Log. of the angle	G ♈ C	19955		54° 59′ 46″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			31° 29′ 30″	
Log. of the hyp.	♈ C	19223			
Log. of the angle	C ♈ F	64937	*A.*		
Log. of the latit.	F C	84160		25° 31′ 57″	Latitude of the comet
Antil. of the hyp.	♈ C	57097			
Antil. of the lat.	C F	10274	*S.*		
Antil. of the long.	♈ F	46823		51° 14′ 12″	Longitude of the comet

Observation 29 [Obſervatio 29.]

On January 1, at 2^{h} 20^{m} 43^{s}, given the declination 42° 38′ 0″ N. and the right ascension 39° 35′ 12″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	30693			
Antil. of the right asc.	♈ G	26051	*A.*		
Antil. of the hyp.	♈ C	56744		55° 27′ 39″	
Log. of the declin.	G C	38963			

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the hyp.	♈ C	19392	*S.*		
Log. of the angle	C ♈ G	19571		55° 18′ 43″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			31° 48′ 27″	
Log. of the hyp.	♈ C	19392			
Log. of the angle	C ♈ F	64044	*A.*		
Log. of the lat.	F C	83436		25° 43′ 53″	Latitude of the comet
Antil. of the hyp.	♈ C	56744			*Bor.*
Antil. of the lat.	C F	10440	*S.*		
Antil. of the long.	♈ F	46304		50° 59′ 47″	Longitude of the comet

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Observation 30 [Obſervatio 30.]

On January 1, at 2^{h} 24^{m} 55^{s}, given the declination 41° 42′ 30″ N. and the right ascension 39° 24′ 53″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	30804			
Antil. of the right asc.	♈ G	25801	*A.*		
Antil. of the hyp.	♈ C	56605		55° 24′ 20″	
Log. of the declin.	G C	38822			
Log. of the hyp.	♈ C	19457	*S.*		
Log. of the angle	G ♈ C	19365		55° 28′ 59″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			31° 58′ 43″	
Log. of the hyp.	♈ C	19457			
Log. of the angle	C ♈ F	63562	*A.*		
Log. of the latit.	F C	83019		25° 50′ 48″	Latitude of the comet
Antil. of the hyp.	♈ C	56605			
Antil. of the latit.	C F	10539	*S.*		
Antil. of the long.	♈ F	46066		50° 53′ 10″	Longitude of the comet

Observation 31 [Obſervatio 31.]

On January 1, at 3^{h} 26^{m} 0^{s}, given the declination 42° 39′ 0″ N. and the right ascension 39° 15′ 8″.

[157] the arc of the angle row is printed "C♈G" where the other calculations print "G♈C"; it is kept as printed. "Bor." stands in the remark column on the line below the latitude.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	30720			
Antil. of the right asc.	♈ G	25571	*A.*		
Antil. of the hyp.	♈ C	56291		55° 16′ 53″	
Log. of the declin.	G C	38932			
Log. of the hyp.	♈ C	19609	*S.*		
Log. of the angle	G ♈ C	19323		55° 31′ 0″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			32° 0′ 44″	
Log. of the hyp.	♈ C	19609			
Log. of the angle	C ♈ F	63468	*A.*		
Log. of the latit.	F C	83077		25° 49′ 51″	Latitude of the comet
Antil. of the hyp.	♈ C	56291			
Antil. of the lat.	C F	10525	*S.*		
Antil. of the long.	♈ F	45766		50° 44′ 45″	Longitude of the comet

Observation 32 [Obſervatio 32.]

On January 1, at 3^{h} 44^{m} 16^{s}, given the declination 42° 38′ 50″ N. and the right ascension 39° 13′ 58″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	30713			
Antil. of the right asc.	♈ G	25543	*A.*		
Antil. of the hyp.	♈ C	56256		55° 16′ 3″	
Log. of the declin.	G C	38938			
Log. of the hyp.	♈ C	19623	*S.*		
Log. of the angle	G ♈ C	19315		55° 31′ 27″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			32° 1′ 11″	
Log. of the hyp.	♈ C	19623			
Log. of the angle	C ♈ F	63447	*A.*		
Log. of the latit.	F C	83070		25° 49′ 58″	Latitude of the comet
Antil. of the hyp.	♈ C	56256			
Antil. of the lat.	C F	10527	*S.*		
Antil. of the long.	♈ F	45729		50° 43′ 42″	Longitude of the comet

Observation 33 [Obſervatio 33.]

On January 4, at 2^{h} 39^{m} 10^{s}, given the declination 46° 16′ 26″ N. and the right ascension 35° 15′ 2″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	36931			
Antil. of the right asc.	♈ G	20256	*A.*		
Antil. of the hyp.	♈ C	57187		55° 38′ 4″	
Log. of the declin.	G C	32482			
Log. of the hyp.	♈ C	19183	*S.*		
Log. of the angle	G ♈ C	13299		61° 6′ 0″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			37° 35′ 44″	
Log. of the hyp.	♈ C	19183			
Log. of the angle	C ♈ F	49418	*A.*		
Log. of the latit.	F C	68601		30° 14′ 15″	Latitude of the comet
Antil. of the hyp.	♈ C	57187			
Antil. of the lat.	C F	14624	*S.*		
Antil. of the long.	♈ F	42563		49° 12′ 17″	Longitude of the comet

Observation 34 [Obſervatio 34.]

On January 4, at 2^{h} 53^{m} 30^{s}, given the declination 45° 37′ 14″ N. and the right ascension 37° 22′ 12″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	35752			
Antil. of the right asc.	♈ G	22975	*A.*		
Antil. of the hyp.	♈ C	58727		56° 14′ 7″	
Log. of the declin.	G C	33587			
Log. of the hyp.	♈ C	18473	*S.*		
Log. of the angle	G ♈ C	15114		59° 17′ 10″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			35° 46′ 54″	
Log. of the hyp.	♈ C	18473			
Log. of the angle	C ♈ F	53664	*A.*		
Log. of the latit.	F C	72137		29° 5′ 1″	Latitude of the comet
Antil. of the hyp.	♈ C	58727			
Antil. of the latit.	C F	13477	*S.*		
Antil. of the long.	♈ F	45250		50° 30′ 12″	Longitude of the comet

Observation 35 [Obſervatio 35.]

On January 7, at 2^{h} 41^{m} 0^{s}, given the declination 47° 55′ 3″ N. and the right ascension 34° 35′ 54″.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the declin.	G C	40017			
Antil. of the right asc.	♈ G	19459	*A.*		
Antil. of the hyp.	♈ C	59476		56° 31′ 0″	
Log. of the declin.	G C	29817			
Log. of the hyp.	♈ C	18147	*S.*		
Log. of the angle	G ♈ C	11670		62° 51′ 20″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ F			39° 21′ 4″	
Log. of the hyp.	♈ C	18147			
Log. of the angle	C ♈ F	45560	*A.*		
Log. of the latit.	F C	63707		31° 55′ 36″	Latitude of the comet
Antil. of the hyp.	♈ C	59476			
Antil. of the lat.	C F	16401	*S.*		
Antil. of the long.	♈ F	43075		49° 27′ 23″	Longitude of the comet

Section VII. To Compute the Comet's Declinations and Right Ascensions from Its Given Longitude and Latitude [SECTIO VII. Datis Cometæ Longitudine, & Latitudine, ſupputare ejus declinationes, & Aſcenſiones Rectas.]

In Section IV we did indeed investigate the comet's declinations and right ascensions from its altitudes and azimuths; but from the observations that were made by means of distances from fixed stars, the declinations and right ascensions still remain to be computed. Let us therefore now set about finding these too, first giving the demonstration — and indeed from the longitudes and latitudes given, as explored in Sect. V. The demonstration of this calculation is evident from almost the same diagrams that were attached to the calculation of the longitudes in the preceding section; it has seemed good to add them again here as well, for the sake of better understanding.

[Margin: Proceſſus calculi pro eruendis declin. & Aſc.Rectis ex longit. & latit.] (Procedure of the calculation for deriving the declinations and right ascensions from the longitude and latitude.)

1. Thus in the right-angled triangle ♈ F C, given the longitude ♈ F and the latitude F C, the two sides about the right angle, let the hypotenuse ♈ C be sought by this rule, namely: the sum of the given logarithms is the antilogarithm of the hypotenuse ♈ C sought. 2. In the same triangle let there also be computed the angle C ♈ F, from the hypotenuse ♈ C just found and the known latitude of the comet F C, namely: by subtracting the logarithm of the hypotenuse ♈ C from the logarithm of the latitude C F, the remainder will be the logarithm of the angle C ♈ F sought. This angle is to be added to the obliquity of the ecliptic ♋ ♈ B if the latitude is northern in a northern sign, or southern in a southern sign; but it is to be subtracted if the latitude is northern in a southern sign, or southern in

a northern sign, so that the angle C ♈ G results. 3. Now in the triangle C ♈ G, the hypotenuse C ♈ and the angle at ♈ being thus known, the declination C G itself also results: the sum of the given logarithms gives the logarithm of the declination. 4. And lastly, in the same triangle, from that same hypotenuse ♈ C and the declination C G, the third side ♈ G, the right ascension, is also derived: if, namely, the antilogarithm of the declination is subtracted from the antilogarithm of the hyp. ♈ C, you will have the antilogarithm of the right ascension from the nearest equinox. In the first quadrant of the ecliptic this is to be retained as the genuine value; in the second quadrant it is to be subtracted from a semicircle; in the third, added to a semicircle; and in the fourth, subtracted from the whole circle. Thus the right ascension sought, reckoned from the beginning of Aries, will result. For example:

Diagram. Three engraved circle diagrams set side by side across the measure, between the paragraph and the two worked calculations, within a rectangular plate mark. In each circle the equator, labelled "Æquator.", runs across from B on the left to A on the right, passing through the sign of Aries near the centre; the ecliptic, labelled "Ecliptica.", runs from the sign of Cancer on the left through the sign of Aries to the sign of Capricorn on the right; the comet C is drawn as an asterisk, and a dotted line joins C to the sign of Aries. Where the left circle meets the middle one, and the middle meets the right, the letters are printed together as "AB". In the left circle C stands below the equator, and two arcs run from D and E at the foot of the circle through C up to G on the equator and F on the ecliptic. In the middle circle E stands at the top and D at the foot; C stands just above the equator, with F above it on the ecliptic and G below it on the equator. In the right circle E and D stand at the top; C stands high in the circle, above the ecliptic, with F on the ecliptic and G on the equator below it. Below the right circle stands the engraver's note "Autor Sculpsit." (the author engraved it). The text describes these as the diagrams of the preceding section, added again here.

- left circle: ♋ (upper left, end of the ecliptic); B (left, end of the equator); F (on the ecliptic); G (on the equator); ♈ (centre); "Æquator." (the equator); C (asterisk, below the equator); "Ecliptica." (the ecliptic); D and E (foot of the circle); ♑ (right, end of the ecliptic)
- between the left and middle circles: AB
- middle circle: E (top); ♋ (left); F; C (asterisk); ♈; "Æquator."; G; "Ecliptica."; ♑ (right); D (foot)
- between the middle and right circles: AB
- right circle: E and D (top); C (asterisk); ♋ (left); F; G; ♈; "Æquator."; A (right, end of the equator); "Ecliptica."; ♑ (right)

Observation 1 [Obſervatio 1.]

Calculation of the declination and right ascension for the year 1652, December 20, at about 7^h in the evening, given the longitude ♊ 8° 24′ 24″ and the latitude 30° 49′ 1″ S.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	99962			
Antil. of the lat.	C F	15221	*A.*		
Antil. of the hyp.	♈ C	115183		71° 34′ 30″	
Log. of the lat.	C F	66884			
Log. of the hyp.	♈ C	5262	*S.*		
Log. of the angle	C ♈ F	61622		32° 40′ 54″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			9° 10′ 38″	
Log. of the hyp.	♈ C	5262			
Log. of the angle	C ♈ G	183759	*A.*		
Log. of the declin.	C G	189021		8° 41′ 14″	Declination of the comet
Antil. of the hyp.	♈ C	115183			*Auſt.*
Antil. of the declin.	C G	1154	*S.*		
Antil. of the right asc.	♈ G	114029		71° 21′ 14″	Right ascension of the comet

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Observation 2 [Obſervatio 2.]

On December 23, at 10^h 15^m 0^s in the evening, given the longitude 58° 44′ 40″ and the latitude 2° 20′ 20″ S.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	65613			
Antil. of the lat.	C F	83	*A.*		
Antil. of the hyp.	♈ C	65696		58° 46′ 24″	
Log. of the lat.	C F	319882			
Log. of the hyp.	♈ C	15651	*S.*		
Log. of the angle	C ♈ F	304231		2° 44′ 7″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			20° 46′ 9″	
Log. of the hyp.	♈ C	15651			
Log. of the angle	C ♈ G	103675	*A.*		
Log. of the declin.	C G	119326		17° 39′ 7″	Declination of the comet

158 "Auſt." stands in the remark column on the line below the declination.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the hyp.	♈ C	65696			*Bor.*
Antil. of the declin.	C G	4823	*S.*		
Antil. of the right asc.	♈ G	60873		57° 2′ 29″	Right ascension of the comet

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Observation 3 [Obſervatio 3.]

On December 26, at about 6^{h} in the evening, given the longitude 54° 37′ 29″ and the latitude 12° 46′ 26″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	54658			
Antil. of the lat.	C F	2506	*A.*		
Antil. of the hyp.	♈ C	57164		55° 37′ 33″	
Log. of the lat.	C F	150913			
Log. of the hyp.	♈ C	19193	*S.*		
Log. of the angle	C ♈ F	131720		15° 32′ 19″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			39° 2′ 35″	
Log. of the hyp.	♈ C	19193			
Log. of the angle	C ♈ G	46219	*A.*		
Log. of the declin.	C G	65412		31° 19′ 31″	Declination of the comet
Antil. of the hyp.	♈ C	57164			*Bor.*
Antil. of the declin.	C G	15755	*S.*		
Antil. of the right asc.	♈ G	41409		48° 37′ 38″	Right ascension of the comet

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Observation 4 [Obſervatio 4.]

On December 26, at 9^{h} 0^{m} 34^{s} in the evening, given the longitude 54° 35′ 30″ and the latitude 13° 24′ 18″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	54576			
Antil. of the lat.	C F	2762	*A.*		
Antil. of the hyp.	♈ C	57338		55° 41′ 39″	
Log. of the lat.	C F	146174			
Log. of the hyp.	♈ C	19112	*S.*		

159 "Bor." stands in the remark column on the line below the declination.
160 "Bor." stands in the remark column on the line below the declination.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the angle	C ♈ F	127062		16° 18′ 2″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			39° 48′ 18″	
Log. of the hyp.	♈ C	19112			
Log. of the angle	C ♈ G	44601	*A.*		
Log. of the declin.	C G	63713		31° 55′ 29″	Declination of the comet
Antil. of the hyp.	♈ C	57338			*Bor.*
Antil. of the declin.	C G	16400	*S.*		
Antil. of the right asc.	♈ G	40938		48° 23′ 24″	Right ascension of the comet

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Observation 5 [Obſervatio 5.]

On December 26, at 11^{h} 48^{m} in the evening, given the longitude 54° 17′ 0″ and the latitude 13° 46′ 38″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	53823			
Antil. of the lat.	C F	2919	*A.*		
Antil. of the hyp.	♈ C	56742		55° 27′ 36″	
Log. of the lat.	C F	143486			
Log. of the hyp.	♈ C	19392	*S.*		
Log. of the angle	C ♈ F	124094		16° 48′ 18″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			40° 18′ 34″	
Log. of the hyp.	♈ C	19392			
Log. of the angle	C ♈ G	43553	*A.*		
Log. of the declin.	C G	62945		32° 12′ 3″	Declination of the comet
Antil. of the hyp.	♈ C	56742			*Bor.*
Antil. of the declin.	C G	16701	*S.*		
Antil. of the right asc.	♈ G	40041		47° 55′ 50″	Right ascension of the comet

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Observation 6 [Obſervatio 6.]

On December 27, at 2^{h} 6^{m} in the morning, given the longitude 54° 17′ 39″ and the latitude 13° 53′ 14″ N.

[161] "Bor." stands in the remark column on the line below the declination.
[162] "Bor." stands in the remark column on the line below the declination.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	53850			
Antil. of the lat.	C F	2967	*A.*		
Antil. of the hyp.	♈ C	56817		55° 29′ 21″	
Log. of the lat.	C F	142706			
Log. of the hyp.	♈ C	19357	*S.*		
Log. of the angle	C ♈ F	123349		16° 56′ 3″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			40° 26′ 19″	
Log. of the hyp.	♈ C	19357			
Log. of the angle	C ♈ G	43289	*A.*		
Log. of the declin.	C G	62646		32° 18′ 30″	Declination of the comet
Antil. of the hyp.	♈ C	56817			*Bor.*
Antil. of the declin.	C G	16821	*S.*		
Antil. of the right asc.	♈ G	39996		47° 54′ 24″	Right ascension of the comet

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Observation 7 [Obſervatio 7.]

On December 27, at 5^{h} 38^{m} 10^{s} in the evening, given the longitude 53° 58′ 10″ and the latitude 16° 11′ 56″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	53066			
Antil. of the lat.	C F	4051	*A.*		
Antil. of the hyp.	♈ C	57117		55° 36′ 26″	
Log. of the lat.	C F	127666			
Log. of the hyp.	♈ C	19215	*S.*		
Log. of the angle	C ♈ F	108451		19° 45′ 32″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			43° 15′ 48″	
Log. of the hyp.	♈ C	19215			
Log. of the angle	C ♈ G	37783	*A.*		
Log. of the declin.	C G	56998		34° 26′ 23″	Declination of the comet
Antil. of the hyp.	♈ C	57117			
Antil. of the declin.	C G	19270	*S.*		
Antil. of the right asc.	♈ G	37847		46° 46′ 18″	Right ascension of the comet

[163] "Bor." stands in the remark column on the line below the declination.

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Observation 8 [Obſervatio 8.]

On December 28, at 1^h 34^m 10^s in the morning, given the longitude 53° 24′ 50″ and the latitude 17° 10′ 50″ N.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antil. of the long.	♈ F	51749			
Antil. of the lat.	C F	4564	*A.*		
Antil. of the hyp.	♈ C	56313		55° 17′ 24″	
Log. of the lat.	C F	121946			
Log. of the hyp.	♈ C	19597	*S.*		
Log. of the angle	C ♈ F	102349		21° 3′ 38″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			44° 33′ 54″	
Log. of the hyp.	♈ C	19597			
Log. of the angle	C ♈ G	35422	*A.*		
Log. of the declin.	C G	55019		35° 13′ 41″	Declination of the comet
Antil. of the hyp.	♈ C	56313			
Antil. of the declin.	C G	20226	*S.*		
Antil. of the right asc.	♈ G	36087		45° 48′ 28″	Right ascension of the comet

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Observation 9 [Obſervatio 9.]

On December 29, at about 4^h 5^m 50^s in the morning, given the longitude 52° 32′ 39″ and the latitude 19° 55′ 21″ N.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antil. of the long.	♈ F	49709			
Antil. of the lat.	C F	6171	*A.*		
Antil. of the hyp.	♈ C	55880		55° 7′ 0″	
Log. of the lat.	C F	107662			
Log. of the hyp.	♈ C	19806	*S.*		
Log. of the angle	C ♈ F	85856		24° 32′ 35″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			48° 2′ 51″	
Log. of the hyp.	♈ C	19806			

[164] the sixth line is labelled "Long. ang." on the page, where the other calculations print "Log. ang.". No "Bor." stands below the declination in this calculation.

[165] no "Bor." stands below the declination in this calculation.

Line	Arc	Logarithm	Mark	Value	Remark
Log. of the angle	C ♈ G	29608	*A.*		
Log. of the declin.	C G	49414		37° 35′ 50″	Declination of the comet
Antil. of the hyp.	♈ C	55880			*Bor.*
Antil. of the declin.	C G	23283	*S.*		
Antil. of the right asc.	♈ G	32597		43° 47′ 38″	Right ascension of the comet

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Observation 10 [Obſervatio 10.]

On December 29, at about 5^{h} in the morning, given the longitude 52° 21′ 35″ and the latitude 20° 32′ 44″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	49314			
Antil. of the lat.	C F	6572	*A.*		
Antil. of the hyp.	♈ C	55886		55° 7′ 11″	
Log. of the lat.	C F	104710			
Log. of the hyp.	♈ C	19803	*S.*		
Log. of the angle	C ♈ F	84907		25° 19′ 45″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			48° 50′ 1″	
Log. of the hyp.	♈ C	19803			
Log. of the angle	C ♈ G	28396	*A.*		
Log. of the declin.	C G	48199		38° 8′ 17″	Declination of the comet
Antil. of the hyp.	♈ C	55886			*Bor.*
Antil. of the declin.	C G	24014	*S.*		
Antil. of the right asc.	♈ G	31872		43° 21′ 26″	Right ascension of the comet

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Observation 11 [Obſervatio 11.]

On December 30, at 6^{h} 10^{m} 30^{s} in the evening, given the longitude 51° 27′ 48″ and the latitude 23° 23′ 17″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	47318			

166 "Bor." stands in the remark column on the line below the declination.

167 "Bor." stands in the remark column on the line below the declination. The last two lines are labelled "Antilog." on the page, the others "Antil.".

Line	Arc	Loga-rithm	Mark	Value	Remark
Antil. of the lat.	C F	8573	*A.*		
Antil. of the hyp.	♈ C	55891		55° 6′ 19″	
Log. of the lat.	C F	92393			
Log. of the hyp.	♈ C	19821	*S.*		
Log. of the angle	C ♈ F	72572		28° 56′ 42″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			52° 26′ 58″	
Log. of the hyp.	♈ C	19821			
Log. of the angle	C ♈ G	23216	*A.*		
Log. of the declin.	C G	43037		40° 33′ 40″	Declination of the comet
Antil. of the hyp.	♈ C	55891			*Bor.*
Antil. of the declin.	C G	27490	*S.*		
Antil. of the right asc.	♈ G	28401		41° 10′ 12″	Right ascension of the comet

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Observation 12 [Obſervatio 12.]

On December 31, at 4^{h} 7^{m} 18^{s} in the morning, given the longitude 51° 28′ 40″ and the latitude 24° 3′ 3″ N.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antil. of the long.	♈ F	47350			
Antil. of the lat.	C F	9082	*A.*		
Antil. of the hyp.	♈ C	56432		55° 20′ 17″	
Log. of the lat.	C F	89759			
Log. of the hyp.	♈ C	19539	*S.*		
Log. of the angle	C ♈ F	70220		29° 42′ 8″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			53° 12′ 24″	
Log. of the hyp.	♈ C	19539			
Log. of the angle	C ♈ G	22213	*A.*		
Log. of the declin.	C G	41752		41° 11′ 51″	Declination of the comet
Antil. of the hyp.	♈ C	56432			
Antil. of the declin.	C G	28441	*S.*		
Antil. of the right asc.	♈ G	27991		40° 54′ 0″	Right ascension of the comet

[168] "Bor." stands in the remark column on the line below the declination. The last two lines are labelled "Antilog." on the page.

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Observation 13 [Observatio 13.]

On January 1, at 2^h 52^m 49^s in the morning, given the longitude 50° 55′ 29″ and the latitude 25° 44′ 43″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	46149			
Antil. of the lat.	C F	10453	*A.*		
Antil. of the hyp.	♈ C	56602		55° 24′ 16″	
Log. of the lat.	C F	83325			
Log. of the hyp.	♈ C	19458	*S.*		
Log. of the angle	C ♈ F	63867		31° 52′ 11″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			55° 22′ 27″	
Log. of the hyp.	♈ C	19458			
Log. of the angle	C ♈ G	19495	*S.*		
Log. of the declin.	C G	38953		42° 38′ 20″	Declination of the comet
Antil. of the hyp.	♈ C	56602			*Bor.*
Antil. of the declin.	C G	30701	*A.*		
Antil. of the right asc.	♈ G	25901		39° 28′ 58″	Right ascension of the comet

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Observation 14 [Observatio 14.]

On January 1, at 3^h 3^m 48^s in the morning, given the longitude 50° 56′ 21″ and the latitude 25° 46′ 12″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	46181			
Antil. of the lat.	C F	10475	*A.*		
Antil. of the hyp.	♈ C	56656		55° 25′ 33″	
Log. of the lat.	C F	83296			
Log. of the hyp.	♈ C	19433	*S.*		
Log. of the angle	C ♈ F	63863		31° 52′ 16″	
Obliquity of the ecliptic				23° 30′ 16″	

[169] no "Bor." stands below the declination in this calculation. On the third line the last figure of 56432 carries a smudged mark above it; the same value stands clear on the twelfth line.

[170] "Bor." stands in the remark column on the line below the declination. In this calculation the tenth line carries the mark "S." and the thirteenth the mark "A.", where the other calculations print "A." and "S." in those places; the figures are nevertheless added on the tenth line (19458 + 19495 = 38953) and subtracted on the thirteenth (56602 − 30701 = 25901).

Line	Arc	Logarithm	Mark	Value	Remark
Angle	C ♈ G			55° 22′ 32″	
Log. of the hyp.	♈ C	19433			
Log. of the angle	C ♈ G	19493	*A.*		
Log. of the declin.	C G	38926		42° 39′ 12″	Declination of the comet
Antil. of the hyp.	♈ C	56656			*Bor.*
Antil. of the declin.	C G	30725	*S.*		
Antil. of the right asc.	♈ G	25931		39° 30′ 13″	Right ascension of the comet

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Observation 15 [Obſervatio 15.]

On January 2, at 6^{h} 27^{m} 30^{s} in the evening, given the longitude 50° 28′ 0″ and the latitude 27° 9′ 0″ N.

Line	Arc	Logarithm	Mark	Value	Remark
Antil. of the long.	♈ F	45173			
Antil. of the lat.	C F	11674	*A.*		
Antil. of the hyp.	♈ C	56847		55° 30′ 4″	
Log. of the lat.	C F	78456			
Log. of the hyp.	♈ C	19342	*S.*		
Log. of the angle	C ♈ F	59114		33° 37′ 16″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			57° 7′ 32″	
Log. of the hyp.	♈ C	19342			
Log. of the angle	C ♈ G	17452	*A.*		
Log. of the declin.	C G	36794		43° 48′ 4″	Declination of the comet
Antil. of the hyp.	♈ C	56847			*Bor.*
Antil. of the declin.	C G	32608	*S.*		
Antil. of the right asc.	♈ G	24239		38° 18′ 7″	Right ascension of the comet

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Observation 16 [Obſervatio 16.]

On January 3, at 6^{h} 47^{m} 30^{s} in the evening, given the longitude 50° 10′ 41″ and the latitude 29° 2′ 40″ N.

171 "Bor." stands in the remark column on the line below the declination.
172 "Bor." stands in the remark column on the line below the declination.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antil. of the long.	♈ F	44567			
Antil. of the lat.	C F	13441	*A.*		
Antil. of the hyp.	♈ C	58008		55° 57′ 16″	
Log. of the lat.	C F	72259			
Log. of the hyp.	♈ C	18803	*S.*		
Log. of the angle	C ♈ F	53456		35° 52′ 6″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			59° 22′ 22″	
Log. of the hyp.	♈ C	18803			
Log. of the angle	C ♈ G	15023	*A.*		
Log. of the declin.	C G	33826		45° 28′ 46″	Declination of the comet
Antil. of the hyp.	♈ C	58008			*Bor.*
Antil. of the declin.	C G	35501	*S.*		
Antil. of the right asc.	♈ G	22507		37° 1′ 0″	Right ascension of the comet

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Observation 17 [Obſervatio 17.]

On January 4, at 2^h 3^m 24^s in the morning, given the longitude 49° 42′ 7″ and the latitude 29° 30′ 46″ N.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antil. of the long.	♈ F	43577			
Antil. of the lat.	C F	13899	*A.*		
Antil. of the hyp.	♈ C	57476		55° 44′ 53″	
Log. of the lat.	C F	70801			
Log. of the hyp.	♈ C	19048	*S.*		
Log. of the angle	C ♈ F	51753		36° 35′ 0″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			60° 5′ 16″	
Log. of the hyp.	♈ C	19048			
Log. of the angle	C ♈ G	14295	*A.*		
Log. of the declin.	C G	33343		45° 45′ 44″	Declination of the comet
Antil. of the hyp.	♈ C	57476			
Antil. of the declin.	C G	36006	*S.*		
Antil. of the right asc.	♈ G	21470		36° 13′ 0″	Right ascension of the comet

173 "Bor." stands in the remark column on the line below the declination.

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Observation 18 [Obſervatio 18.]

On January 7, at 2^h 26^m 9^s in the morning, given the longitude 49° 41′ 56″ and the latitude 31° 50′ 26″ N.

Line	Arc	Loga-rithm	Mark	Value	Remark
Antil. of the long.	♈ F	43573			
Antil. of the lat.	C F	16309	*A.*		
Antil. of the hyp.	♈ C	59882		56° 40′ 13″	
Log. of the lat.	C F	63949			
Log. of the hyp.	♈ C	17970	*S.*		
Log. of the angle	C ♈ F	45979		39° 9′ 17″	
Obliquity of the ecliptic				23° 30′ 16″	
Angle	C ♈ G			62° 39′ 33″	
Log. of the hyp.	♈ C	17970			
Log. of the angle	C ♈ G	11847	*A.*		
Log. of the declin.	C G	29817		47° 55′ 0″	Declination of the comet
Antil. of the hyp.	♈ C	59882			
Antil. of the declin.	C G	40016	*S.*		
Antil. of the right asc.	♈ G	19866		34° 56′ 0″	Right ascension of the comet

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Section VIII. To Investigate the Comet's Digressions, or Distances, from the Sun [SECTIO VIII. Cometæ à Sole digreſſiones, ſeu diſtantias inveſtigare.]

Now, in the same way, let us find the comet's elongations from the Sun for all the observations whose longitude and latitude, declination and right ascension have been computed. This is very easily done: it needs the solution of only one right-angled triangle, from the given longitudes of the Sun and the comet and the comet's latitude. For example, in the following diagram let A B D be the ecliptic, E and F its poles, E B and F B circles of latitude, C the comet, C B its latitude, and S the place of the Sun. Therefore, in the triangle right-angled at B, there are known two sides: S B, the difference between the longitudes of the Sun and the comet, and also B C, the comet's latitude. Let the hypotenuse S C, the comet's distance from the Sun, be sought in this way. The sum of the antilogarithms of the two sides is the antilogarithm of the distance sought. This holds, however, on the express condition that the longitude of the Sun and the longitude of the comet lie in one and the same quadrant; or indeed in different

[174] the sixth line is labelled "Long. ang." on the page, where the other calculations print "Log. ang.". No "Bor." stands below the declination in this calculation.

[175] no "Bor." stands below the declination in this calculation.

quadrants, provided that the difference of the longitudes does not exceed 90 degrees. But if the difference between the Sun and the comet exceeds 90, or 180, or 270 degrees, then one must use quite different rules, according as the longitude of the Sun is found in one quadrant or another with respect to the longitude of the comet. Sometimes this calculation is carried out by logarithms alone, as appears in our first example, where the longitude of the Sun lies in the third quadrant and that of the comet in the first. But when the place of the Sun is given in the fourth quadrant and that of the comet likewise in the first, as in all the remaining examples that follow, except the single preceding one, then the antilogarithm of the latitude is to be added to the logarithm of the difference of the longitudes of the comet and the Sun. The sum will be an antilogarithm whose arc is to be subtracted from the semicircle, so that the distance itself between the Sun and the comet results.

Diagram. A circle within a rectangular plate mark, set to the left of the narrow column of text. A great arc runs from E at the upper right of the rim, through the upper comet C and through B, down to F at the foot of the rim; it is labelled "Latitudinis." along its upper part and "Circuli" along its lower part (circle of latitude). The ecliptic, labelled "Ecliptica.", runs from D on the left rim through B to the small circle of the Sun near A on the right rim. Two comets are drawn, each as a small circle with a hatched tail: an upper one beside the letter C, with "Comet" along its tail, and a lower one on the left rim, with C below it and "Cometa" along its tail. From each comet a line runs to the Sun, labelled "Diſtant. Com. à Sole." along the upper line and "Diſt Com à Sole." along the lower (distance of the comet from the Sun). Above the Sun stands S, below it "Sol." (the Sun), and beyond it A on the rim. "Colurus" stands at the upper left of the rim and "Solſtitiorum." along the right rim (the solstitial colure). Below the circle, at the right, stands the engraver's note "Autor Sculps." (the author engraved it).

- E (upper right, on the rim, end of the circle of latitude)
- "Colurus" (upper left of the rim)
- "Comet" (along the tail of the upper comet; the word runs into the comet's head and no further letter is visible)
- C (beside the upper comet)
- "Latitudinis." (along the arc from C toward E)
- "Solſtitiorum." (along the right rim)
- D (left, on the rim, end of the ecliptic)
- B (where the circle of latitude crosses the ecliptic)
- "Diſtant. Com. à Sole." (along the line from the upper comet to the Sun)
- "Cometa" (along the tail of the lower comet)
- "Ecliptica." (along the ecliptic)
- C (below the lower comet)
- "Diſt Com à Sole." (along the line from the lower comet to the Sun)
- S (above the Sun)
- "Sol." (below the Sun)

- A (right, on the rim, beyond the Sun)
- "Circuli" (along the lower part of the arc toward F)
- F (foot of the rim)
- "Autor Sculps." (below the circle, at the right)

Observation 1 [Obſervatio 1.]

On December 20, at 7^h in the evening: the distance between the Sun and the comet sought.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	269° 39′ 12″			
Complement to 3 quadrants	20′ 48″			
Longitude of the comet	68° 24′ 24″			
Log. of the difference	68° 45′ 12″	7039		
Antil. of the comet's latitude *M.*	30° 49′ 1″	15221	*Add.*	
Logarithm		22260		36° 49′ 38″
Its complement to 180° is the distance sought				143° 10′ 22″

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Observation 2 [Obſervatio 2.]

On December 23, at 7^h 22^m 7^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	272° 44′ 3″			
Excess over 3 quadrants	2° 44′ 3″			
Longitude of the comet	58° 56′ 24″			
Difference; its log.	56° 12′ 21″	18508		
Latitude, *A.* antil.	3° 0′ 21″	138	*Add.*	
Antilogarithm		18646		33° 54′ 50″
Its complement to 180° is the distance sought				146° 5′ 10″

Observation 3 [Obſervatio 3.]

On December 23, at 10^h 15^m 0^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	272° 51′ 25″			
Excess over 3 quadrants	2° 51′ 25″			
Longitude of the comet	58° 44′ 40″			

[176] on the page the fifth line sets its label first, then the latitude, then "M." directly before the logarithm. The complement to 3 quadrants is printed in the minutes and seconds columns only, with no degree figure.

Line	Value	Logarithm	Mark	Result
Difference; its log.	55° 53′ 15″	18881		
Latitude, *M.* antilog.	2° 20′ 20″	83	*Add.*	
Antilogarithm		18964		34° 10′ 57″
Its complement to 180° is the distance sought				145° 49′ 3″

Observation 4 [Obſervatio 4.]

On December 23, at 10^{h} 57^{m} 20^{s} in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	272° 53′ 14″			
Excess over 3 quadrants	2° 53′ 14″			
Longitude of the comet	59° 1′ 41″			
Difference; its log.	56° 8′ 27″	18585		
M. Latitude; its antil.	1° 43′ 23″	45	*A.*	
Antilog.		18630		33° 53′ 59″
Its complement to 180° is the distance sought				146° 6′ 1″

Observation 5 [Obſervatio 5.]

On December 23, at 11^{h} 28^{m} 0^{s} in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	272° 54′ 31″			
Excess over 3 quadrants	2° 54′ 31″			
Longitude of the comet	58° 48′ 13″			
Difference; its log.	55° 53′ 42″	18865		
M. Latitude; its antil.	1° 30′ 56″	35	*A.*	
Antil.		18900		34° 7′ 10″
Its complement to 180° is the distance sought				145° 52′ 50″

Observation 6 [Obſervatio 6.]

On December 24, at 1^{h} 27^{m} 30^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	272° 59′ 36″			
Excess over 3 quadrants	2° 59′ 36″			
Longitude of the comet	58° 46′ 25″			
Difference; its log.	55° 46′ 49″	19010		
M. Latitude; its antil.	0° 57′ 21″	14	*A.*	
Antilog.		19024		34° 14′ 0″
Its complement to 180° is the distance sought				145° 46′ 0″

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Observation 7 [Observatio 7.]

On December 24, at 1^h 44^m 15^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	273° 0′ 20″			
Excess over 3 quadrants	3° 0′ 20″			
Longitude of the comet	57° 58′ 29″			
Difference; its log.	54° 58′ 9″	19986		
M. Latitude; its antil.	0° 31′ 20″	4	*A.*	
Antilogarithm		19990		35° 2′ 3″
Its complement to 180° is the distance sought				144° 57′ 57″

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Observation 8 [Observatio 8.]

On December 26, at 6^h 0^m 0^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	275° 44′ 30″			
Excess over 3 quadrants	5° 44′ 30″			
Longitude of the comet	54° 37′ 29″			
Difference; its log.	48° 52′ 59″	28320		
Northern latitude; its antil.	12° 46′ 26″	2506	*A.*	
Antilog.		30826		42° 43′ 0″
Its complement to 180° is the distance sought				137° 17′ 0″

Observation 9 [Observatio 9.]

On December 26, at 9^h 0^m 34^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	275° 52′ 10″			
Excess over 3 quadrants	5° 52′ 10″			
Longitude of the comet	54° 35′ 30″			
Difference; its log.	48° 43′ 20″	28566		
Northern latitude; its antil.	13° 24′ 18″	2762	*A.*	
Antilog.		31328		43° 1′ 30″
Its complement to 180° is the distance sought				136° 58′ 30″

[177] in this calculation the page prints a 0 in the degrees column of the latitude.
[178] in this calculation the page prints a 0 in the degrees column of the latitude.

Observation 10 [Observatio 10.]

On December 26, at 11^h 38^m 22^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	275° 58′ 55″			
Excess over 3 quadrants	5° 58′ 55″			
Longitude of the comet	54° 33′ 53″			
Difference; its log.	48° 34′ 58″	28805		
Northern latitude; its antil.	13° 41′ 27″	2882	*A.*	
Antilogarithm		31687		43° 14′ 40″
Its complement to 180° is the distance sought				136° 45′ 20″

Observation 11 [Observatio 11.]

On December 26, at 11^h 44^m 48^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	275° 59′ 10″			
Excess over 3 quadrants	5° 59′ 10″			
Longitude of the comet	54° 25′ 17″			
Difference; its log.	48° 26′ 7″	29008		
Northern latitude; its antil.	13° 42′ 14″	2888	*A.*	
Antilog.		31896		43° 22′ 20″
Its complement to 180° is the distance sought				136° 37′ 40″

Observation 12 [Observatio 12.]

On December 26, at 11^h 48^m 0^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 0′ 28″			
Excess over 3 quadrants	6° 0′ 28″			
Longitude of the comet	54° 17′ 0″			
Difference; its log.	48° 16′ 32″	29256		
Northern latitude; its antil.	13° 46′ 38″	2919	*A*	
Antilog.		32175		43° 32′ 26″
Its complement to 180° is the distance sought				136° 27′ 34″

Observation 13 [Observatio 13.]

On December 26, at 11^h 50^m 31^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	275° 59′ 27″			
Excess over 3 quadrants	5° 59′ 27″			
Longitude of the comet	54° 16′ 17″			
Difference; its log.	48° 16′ 50″	29249		
Northern latitude; its antil.	13° 48′ 43″	2934	*A.*	
Antilog.		32183		43° 32′ 42″
Its complement to 180° is the distance sought				136° 27′ 8″

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Observation 14 [Obſervatio 14.]

On December 27, at 12^{h} 48^{m} 15^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 1′ 53″			
Excess over 3 quadrants	6° 1′ 53″			
Longitude of the comet	54° 40′ 30″			
Difference; its log.	48° 38′ 57″	28680		
Northern latitude; its antil.	13° 38′ 48″	2864	*A.*	
Antilog.		31544		43° 6′ 26″
Its complement to 180° is the distance sought				136° 53′ 34″

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Observation 15 [Obſervatio 15.]

On December 27, at 12^{h} 55^{m} 15^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 2′ 11″			
Excess over 3 quadrants	6° 2′ 11″			
Longitude of the comet	54° 7′ 0″			
Difference; its log.	48° 4′ 49″	29560		
Northern latitude; its antil.	14° 11′ 39″	3101	*A.*	
Antilog.		32661		43° 49′ 54″
Its complement to 180° is the distance sought				136° 10′ 6″

Observation 16 [Obſervatio 16.]

On December 27, at 1^{h} 24^{m} 45^{s} in the morning.

[179] the complement is printed 136° 27′ 8″; 180° − 43° 32′ 42″ gives 136° 27′ 18″.
[180] the difference is printed 48° 38′ 57″; 54° 40′ 30″ − 6° 1′ 53″ gives 48° 38′ 37″.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 3′ 25″			
Excess over 3 quadrants	6° 3′ 25″			
Longitude of the comet	54° 10′ 12″			
Difference; its log.	48° 6′ 47″	29510		
Northern latitude; its antil.	14° 41′ 24″	3323	*A.*	
Antilog.		32833		43° 56′ 6″
Its complement to 180 is the distance sought				136° 3′ 54″

Observation 17 [Obſervatio 17.]

On December 27, at 2^h 6^m 0^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 5′ 12″			
Excess over 3 quadrants	6° 5′ 12″			
Longitude of the comet	54° 17′ 39″			
Difference; its log.	48° 12′ 27″	29362		
Northern latitude; its antil.	13° 53′ 14″	2966	*A.*	
Antilog.		32328		43° 38′ 0″
Its complement to 180° is the distance sought				136° 22′ 0″

Observation 18 [Obſervatio 18.]

On December 27, at 5^h 14^m 5^s in the evening.

Line	Value	Loga-rithm	Mark	Result
Longitude of the Sun	276° 43′ 51″			
Excess over 3 quadrants	6° 43′ 51″			
Longitude of the comet	53° 15′ 27″			
Difference; its log.	46° 31′ 36″	32061		
Northern latitude; its antil.	16° 1′ 22″	3962	*A.*	
Antilog.		36023		45° 46′ 20″
Its complement to 180° is the distance sought				134° 13′ 40″

Observation 19 [Obſervatio 19.]

On December 27, at 5^h 19^m 1^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 44′ 4″			
Excess over 3 quadrants	6° 44′ 4″			
Longitude of the comet	53° 34′ 51″			
Difference; its log.	46° 50′ 47″	31535		
Northern latitude; its antil.	16° 2′ 31″	3972	*A.*	
Antilog.		35507		45° 28′ 58″

Line	Value	Logarithm	Mark	Result
Its complement to 180° is the distance sought				134° 31′ 2″

Observation 20 [Obſervatio 20.]

On December 27, at 5^{h} 23^{m} 58^{s} in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 44′ 15″			
Excess over 3 quadrants	6° 44′ 15″			
Longitude of the comet	53° 39′ 26″			
Difference; its log.	46° 55′ 11″	31416		
Northern latitude; its antil.	16° 13′ 43″	4066	*A.*	
Antilog.		35482		45° 28′ 8″
Its complement to 180° is the distance sought				134° 31′ 52″

Observation 21 [Obſervatio 21.]

On December 27, at 5^{h} 33^{m} 39^{s} in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 44′ 41″			
Excess over 3 quadrants	6° 44′ 41″			
Longitude of the comet	53° 58′ 30″			
Difference; its log.	47° 13′ 49″	30914		
Northern latitude; its antil.	16° 5′ 34″	3997	*A.*	
Antilog.		34911		45° 8′ 40″
Its complement to 180° is the distance sought				134° 51′ 20″

Observation 22 [Obſervatio 22.]

On December 27, at 5^{h} 38^{m} 10^{s} in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 46′ 6″			
Excess over 3 quadrants	6° 46′ 6″			
Longitude of the comet	53° 58′ 10″			
Difference; its log.	47° 12′ 4″	30959		
Northern latitude; its antil.	16° 11′ 56″	4051	*A.*	
Antil.		35010		45° 12′ 4″
Its complement to 180° is the distance sought				134° 47′ 54″

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[181]the complement is printed 134° 47′ 54″; 180° − 45° 12′ 4″ gives 134° 47′ 56″.

Observation 23 [Obſervatio 23.]

On December 27, at 5^h 40^m 48^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 45′ 0″			
Excess over 3 quadrants	6° 45′ 0″			
Longitude of the comet	53° 52′ 20″			
Difference; its log.	47° 7′ 20″	31088		
Northern latitude; its antil.	16° 12′ 25″	4055	*A.*	
Antilog.		35143		45° 16′ 36″
Its complement to 180° is the distance sought				134° 43′ 24″

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Observation 24 [Obſervatio 24.]

On December 27, at 5^h 50^m 9^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	276° 45′ 24″			
Excess over 3 quadrants	6° 45′ 24″			
Longitude of the comet	53° 34′ 26″			
Difference; its log.	46° 49′ 2″	31581		
Northern latitude; its antilog.	16° 21′ 14″	4130	*A.*	
Antilogarithm		35711		45° 35′ 50″
Its complement to 180° is the distance sought				134° 24′ 10″

Observation 25 [Obſervatio 25.]

On December 27, at 11^h 44^m 31^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	277° 0′ 27″			
Excess over 3 quadrants	7° 0′ 27″			
Longitude of the comet	53° 23′ 24″			
Difference; its log.	46° 22′ 57″	32300		
Northern latitude; its antil.	17° 5′ 57″	4520	*A.*	
Antilogarithm		36820		46° 12′ 28″
Its complement to 180° is the distance sought				133° 47′ 32″

[182] the first label is printed "Longit. Sobis".

Observation 26 [Obſervatio 26.]

On December 27, at 11^h 52^m 31^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	277° 0′ 49″			
Complement to 3 quadrants	7° 0′ 49″			
Longitude of the comet	53° 13′ 36″			
Log. of the difference	46° 12′ 47″	32583		
Northern latitude; its antil.	17° 1′ 32″	4482	*A.*	
Logarithm		37065		46° 20′ 52″
Its complement to 180° is the distance sought				133° 39′ 8″

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Observation 27 [Obſervatio 27.]

On December 28, at 12^h 13^m 46^s in the morning.

Line	Value	Loga-rithm	Mark	Result
Longitude of the Sun	277° 1′ 43″			
Excess over 3 quadrants	7° 1′ 43″			
Longitude of the comet	53° 14′ 19″			
Difference; its log.	46° 13′ 36″	32560		
Northern latitude; its antil.	17° 6′ 7″	4522	*A.*	
Antilogarithm		37082		46° 21′ 24″
Its complement to 180° is the distance sought				133° 38′ 36″

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Observation 28 [Obſervatio 28.]

On December 28, at 1^h 34^m 10^s in the morning.

Line	Value	Loga-rithm	Mark	Result
Longitude of the Sun	277° 5′ 10″			
Excess over 3 quadrants	7° 5′ 10″			
Longitude of the comet	53° 24′ 50″			
Difference; its log.	46° 19′ 40″	32390		
Northern latitude; its antil.	17° 10′ 50″	4564	*A.*	
Antilog.		36954		46° 17′ 12″
Its complement to 180° is the distance sought				133° 42′ 48″

[183] the second line is labelled "Complem. ad 3 quad." (complement to 3 quadrants), although its figure is the excess of the Sun's longitude over 270°, as in the other calculations of this kind.

[184] the difference is printed 46° 13′ 36″; 53° 14′ 19″ − 7° 1′ 43″ gives 46° 12′ 36″.

Observation 29 [Observatio 29.]

On December 29, at 3^h 50^m 52^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	278° 12′ 18″			
Excess over 3 quadrants	8° 12′ 18″			
Longitude of the comet	51° 40′ 33″			
Difference; its log.	43° 28′ 15″	37399		
Northern latitude; its antil.	20° 20′ 28″	6439	*A.*	
Antilog.		43838		49° 49′ 40″
Its complement to 180° is the distance sought				130° 10′ 20″

Observation 30 [Observatio 30.]

On December 29, at 3^h 55^m 52^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	278° 12′ 33″			
Excess over 3 quadrants	8° 12′ 33″			
Longitude of the comet	51° 25′ 58″			
Difference; its log.	43° 13′ 25″	37857		
Northern latitude; its antil.	20° 13′ 28″	6364	*A.*	
Antilogarithm		44221		50° 0′ 45″
Its complement to 180° is the distance sought				129° 59′ 15″

Observation 31 [Observatio 31.]

On December 29, at 4^h 5^m 50^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	278° 15′ 3″			
Excess over 3 quadrants	8° 15′ 3″			
Longitude of the comet	52° 32′ 39″			
Difference; its log.	44° 17′ 36″	35906		
Northern latitude; its antil.	19° 55′ 21″	6171	*A.*	
Antilog.		42077		48° 57′ 45″
Its complement to 180° is the distance sought				131° 2′ 15″

Observation 32 [Observatio 32.]

On December 29, at 4^h 28^m 50^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	278° 13′ 55″			

Line	Value	Logarithm	Mark	Result
Excess over 3 quadrants	8° 13′ 55″			
Longitude of the comet	52° 56′ 37″			
Difference; its log.	44° 42′ 42″	35163		
Northern latitude; its antil.	19° 23′ 14″	5837	*A.*	
Antilog.		41000		48° 25′ 18″
Its complement to 180° is the distance sought				131° 34′ 42″

Observation 33 [Obſervatio 33.]

On December 29, at 4^{h} 47^{m} 49^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	278° 14′ 44″			
Excess over 3 quadrants	8° 14′ 44″			
Longitude of the comet	51° 28′ 3″			
Difference; its log.	43° 13′ 19″	37860		
Northern latitude; its antil.	20° 7′ 37″	6301	*A*	
Antilog.		44161		49° 59′ 3″
Its complement to 180° is the distance sought				130° 0′ 57″

Observation 34 [Obſervatio 34.]

On December 29, at about 5^{h} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	278° 16′ 25″			
Excess over 3 quadrants	8° 16′ 25″			
Longitude of the comet	52° 21′ 35″			
Difference; its log.	44° 5′ 10″	36278		
Northern latitude; its antil.	20° 32′ 44″	6572	*A.*	
Antilog.		42850		49° 20′ 43″
Its complement to 180° is the distance sought				130° 39′ 17″

Observation 35 [Obſervatio 35.]

On December 30, at 6^{h} 10^{m} 30^{s} in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	279° 50′ 12″			
Excess over 3 quadrants	9° 50′ 12″			
Longitude of the comet	51° 27′ 48″			
Difference; its log.	41° 37′ 36″	40908		
Northern latitude; its antil.	23° 23′ 17″	8573	*A.*	

Line	Value	Logarithm	Mark	Result
Antilog.		49481		52° 26′ 0″
Its complement to 180° is the distance sought				127° 34′ 0″

Observation 36 [Obſervatio 36.]

On December 31, at 3^h 37^m 26^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	280° 14′ 9″			
Excess over 3 quadrants	10° 14′ 9″			
Longitude of the comet	51° 14′ 22″			
Difference; its log.	4° 0′ 13″	42142		
Northern latitude; its antil.	23° 58′ 19″	9020	*A.*	
Antilog.		51162		53° 9′ 55″
Its complement to 180 is the distance sought				126° 50′ 5″

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Observation 37 [Obſervatio 37.]

On December 31, at 3^h 44^m 24^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	280° 14′ 27″			
Excess over 3 quadrants	10° 14′ 27″			
Longitude of the comet	51° 18′ 48″			
Difference; its log.	41° 4′ 21″	42004		
Northern latitude; its antil.	23° 48′ 51″	8897	*A.*	
Antilog.		52901		53° 3′ 9″
Its complement to 180° is the distance sought				126° 56′ 51″

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Observation 38 [Obſervatio 38.]

On December 31, at 4^h 7^m 18^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	280° 15′ 48″			
Excess over 3 quadrants	10° 15′ 48″			

[185] the degrees of the difference are printed as the single figure 4; 51° 14′ 22″ − 10° 14′ 9″ gives 41° 0′ 13″.

[186] the summed antilogarithm is printed 52901; 42004 + 8897 gives 50901.

Line	Value	Logarithm	Mark	Result
Longitude of the comet	51° 28′ 40″			
Difference; its log.	41° 12′ 52″	41722		
Northern latitude; its antil.	24° 3′ 3″	9082	*A.*	
Antilog.		50804		53° 0′ 40″
Its complement to 180° is the distance sought				126° 59′ 20″

Observation 39 [Obſervatio 39.]

On December 31, at 4^{h} 27^{m} 22^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	280° 16′ 18″			
Excess over 3 quadrants	10° 16′ 18″			
Longitude of the comet	51° 4′ 0″			
Difference; its log.	40° 47′ 42″	42562		
Northern latitude; its antil.	24° 16′ 40″	9259	*A.*	
Antilog.		51821		53° 26′ 41″
Its complement to 180° is the distance sought				126° 33′ 19″

Observation 40 [Obſervatio 40.]

On January 1, in the year 1653, at 2^{h} 15^{m} 40^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	281° 12′ 14″			
Excess over 3 quadrants	11° 12′ 14″			
Longitude of the comet	51° 14′ 12″			
Difference; its log.	40° 1′ 58″	44125		
Northern latitude; its antil.	25° 31′ 57″	10277	*A.*	
Antilog.		54402		54° 31′ 15″
Its complement to 180° is the distance sought				125° 28′ 45″

Observation 41 [Obſervatio 41.]

On January 1, at 2^{h} 20^{m} 43^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	281° 12′ 25″			
Excess over 3 quadrants	11° 12′ 25″			
Longitude of the comet	50° 59′ 47″			
Difference; its log.	39° 47′ 22″	44633		
Northern latitude; its antil.	25° 43′ 53″	10441	*A.*	
Antilog.		55074		54° 47′ 37″

Line	Value	Logarithm	Mark	Result
Its complement to 180° is the distance sought				125° 12′ 23″

Observation 42 [Obſervatio 42.]

On January 1, at 2^h 24^m 55^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	281° 12′ 35″			
Excess over 3 quadrants	11° 12′ 35″			
Longitude of the comet	50° 53′ 10″			
Difference; its log.	39° 40′ 35″	44870		
Northern latitude; its antil.	25° 50′ 48″	10538	*A.*	
Antil.		55408		54° 55′ 41″
Its complement to 180° is the distance sought				125° 4′ 19″

Observation 43 [Obſervatio 43.]

On January 1, at 2^h 52^m 49^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	281° 13′ 46″			
Excess over 3 quadrants	11° 13′ 46″			
Longitude of the comet	50° 55′ 29″			
Difference; its log.	39° 41′ 43″	44830		
Northern latitude; its antil.	25° 44′ 43″	10453	*A.*	
Antilog.		55283		54° 52′ 40″
Its complement to 180° is the distance sought				125° 7′ 20″

Observation 44 [Obſervatio 44.]

On January 1, at 3^h 3^m 48^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	281° 14′ 14″			
Excess over 3 quadrants	11° 14′ 14″			
Longitude of the comet	50° 56′ 21″			
Difference; its log.	39° 42′ 7″	44817		
Northern latitude; its antilog.	25° 46′ 12″	10475	*A.*	
Antilogarithm		55292		54° 52′ 53″
Its complement to 180° is the distance sought				125° 7′ 7″

Observation 45 [Obſervatio 45.]

On January 1, at 3^h 3^m 48^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	281° 14′ 14″			
Excess over 3 quadrants	11° 14′ 14″			
Longitude of the comet	50° 55′ 24″			
Difference; its log.	39° 41′ 10″	44850		
Northern latitude; its antil.	25° 44′ 25″	10449	*A.*	
Antilogarithm		55299		54° 53′ 4″
Its complement to 180° is the distance sought				125° 6′ 56″

Observation 46 [Obſervatio 46.]

On January 1, at 3^h 26^m 0^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	281° 15′ 12″			
Complement to 3 quadrants	11° 15′ 12″			
Longitude of the comet	50° 44′ 45″			
Log. of the difference	39° 29′ 33″	45259		
Northern latitude; its antil.	25° 49′ 51″	10525	*A.*	
Logarithm		55784		55° 4′ 44″
Its complement to 180° is the distance sought				124° 55′ 16″

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Observation 47 [Obſervatio 47.]

On January 1, at 3^h 44^m 16^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	281° 15′ 58″			
Excess over 3 quadrants	11° 15′ 58″			
Longitude of the comet	50° 43′ 42″			
Difference; its log.	39° 27′ 44″	45323		
Northern latitude; its antil.	25° 49′ 58″	10527	*A.*	
Antilogarithm		55850		55° 6′ 20″
Its complement to 180° is the distance sought				124° 53′ 40″

[187] as in Observation 26, the second line is labelled "Complem. ad 3 quad." (complement to 3 quadrants), although its figure is the excess of the Sun's longitude over 270°.

Observation 48 [Obſervatio 48.]

On January 2, at 6^h 27^m 30^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	282° 54′ 53″			
Excess over 3 quadrants	12° 54′ 53″			
Longitude of the comet	50° 28′ 0″			
Difference; its log.	37° 33′ 7″	49477		
Northern latitude; its antil.	27° 9′ 0″	11674	*A.*	
Antilog.		61151		57° 8′ 36″
Its complement to 180° is the distance sought				122° 51′ 24″

Observation 49 [Obſervatio 49.]

On January 3, at 6^h 47^m 30^s in the evening.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	283° 57′ 1″			
Excess over 3 quadrants	13° 57′ 1″			
Longitude of the comet	50° 10′ 41″			
Difference; its log.	36° 13′ 40″	52593		
Northern latitude; its antil.	29° 2′ 40″	13441	*A.*	
Antilog.		66034		58° 53′ 26″
Its complement to 180° is the distance sought				121° 6′ 34″

Observation 50 [Obſervatio 50.]

On January 4, at 2^h 3^m 24^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	284° 15′ 35″			
Excess over 3 quadrants	14° 15′ 35″			
Longitude of the comet	49° 42′ 7″			
Difference; its log.	35° 26′ 32″	54494		
Northern latitude; its antil.	29° 30′ 46″	13899	*A.*	
Antilogarithm		68393		59° 41′ 37″
Its complement to 180° is the distance sought				120° 18′ 23″

Observation 51 [Obſervatio 51.]

On January 4, at 2^h 39^m 10^s in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	284° 17′ 6″			

Line	Value	Logarithm	Mark	Result
Excess over 3 quadrants	14° 17′ 6″			
Longitude of the comet	49° 12′ 17″			
Difference; its log.	34° 55′ 11″	55787		
Northern latitude; its antil.	30° 14′ 15″	14624	*A.*	
Antilog.		70411		60° 21′ 34″
Its complement to 180° is the distance sought				119° 38′ 26″

Observation 52 [Obſervatio 52.]

On January 4, at 2^{h} 53^{m} 30^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	284° 17′ 58″			
Excess over 3 quadrants	14° 17′ 58″			
Longitude of the comet	50° 30′ 12″			
Difference; its log.	36° 12′ 14″	52651		
Northern latitude; its antil.	29° 5′ 1″	13477	*A*	
Antilog.		66128		58° 55′ 23″
Its complement to 180° is the distance sought				121° 4′ 37″

Observation 53 [Obſervatio 53.]

On January 7, at 2^{h} 26^{m} 9^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	287° 20′ 24″			
Excess over 3 quadrants	17° 20′ 24″			
Longitude of the comet	49° 41′ 56″			
Difference; its log.	32° 21′ 32″	62506		
Northern latitude; its antil.	31° 50′ 26″	16309	*A.*	
Antilog.		78815		62° 57′ 18″
Its complement to 180° is the distance sought				117° 2′ 42″

Observation 54 [Obſervatio 54.]

On January 7, at 2^{h} 41^{m} 0^{s} in the morning.

Line	Value	Logarithm	Mark	Result
Longitude of the Sun	287° 21′ 3″			
Excess over 3 quadrants	17° 21′ 3″			
Longitude of the comet	49° 27′ 23″			
Difference; its log.	32° 6′ 20″	63208		
Northern latitude; its antil.	31° 55′ 36″	16401	*A.*	

Line	Value	Logarithm	Mark	Result
Antilog.		79609		63° 11′ 11″
Its complement to 180° is the distance sought				116° 48′ 49″

Having thus computed the comet's longitudes and latitudes, declinations and right ascensions, and also its elongations from the Sun, by means both of the altitudes and azimuths and of the distances, it will also be worthwhile to gather all of them into a single table, so that the apparent place of the comet on any day may be more readily available to anyone.

A table showing the place of the comet, both with respect to the ecliptic and the equator, and its distance from the Sun.

Year 1652; day	Corrected time	Longitude	Sign	Latitude	Mark	Declination	Mark	Right ascension	Distance of the comet from the Sun	
December 20	$7^h\ 0^m\ 0^s$ *v.*	8° 24′ 24″	♊	30° 49′ 1″	*A.*	8° 41′ 14″	*A.*	71° 21′ 14″	143° 10′ 22″	From the distances
December 23	$7^h\ 22^m\ 7^s$ *v.*	28° 56′ 26″	♋	3° 0′ 21″	*A.*	17° 2′ 26″	*B.*	57° 23′ 30″	146° 5′ 10″	
	$10^h\ 15^m\ 0^s$ *v.*	28° 44′ 46″	♋	2° 20′ 20″	*A.*	17° 39′ 7″	*B.*	57° 2′ 29″	145° 49′ 3″	From the distances
	$10^h\ 57^m\ 20^s$ *v.*	29° 1′ 41″	♋	1° 43′ 23″	*A.*	18° 18′ 51″	*B.*	57° 11′ 27″	146° 6′ 1″	
	$11^h\ 28^m\ 0^s$ *v.*	28° 48′ 13″		1° 30′ 56″		18° 28′ 3″		56° 54′ 53″	145° 52′ 50″	
December 24	$1^h\ 27^m\ 30^s$ *m.*	28° 46′ 25″		0° 57′ 21″		19° 0′ 28″		56° 45′ 14″	145° 46′ 0″	
	$1^h\ 44^m\ 15^s$ *m.*	27° 58′ 29″	♋	0° 31′ 20″	*A.*	19° 15′ 13″	*B.*	55° 49′ 42″	144° 57′ 57″	
December 26	$6^h\ 0^m\ 0^s$ *v.*	24° 37′ 29″		12° 46′ 28″	*B.*	31° 19′ 31″		48° 37′ 38″	137° 17′ 0″	From the distances
	$9^h\ 0^m\ 34^s$ *v.*	24° 35′ 30″		13° 24′ 18″		31° 55′ 29″		48° 23′ 24″	136° 58′ 30″	From the distances
	$11^h\ 38^m\ 22^s$ *v.*	24° 33′ 53″	♌	13° 41′ 27″	*B.*	32° 11′ 35″	*B.*	48° 16′ 9″	136° 45′ 20″	
	$11^h\ 44^m\ 48^s$ *v.*	24° 25′ 17″		13° 42′ 14″		32° 10′ 11″		48° 6′ 26″	136° 37′ 40″	
	$11^h\ 48^m\ 0^s$ *v.*	24° 17′ 0″		13° 46′ 38″		32° 12′ 3″		47° 55′ 50″	136° 27′ 34″	From the distances
	$11^h\ 50^m\ 31^s$ *v.*	24° 16′ 13″	♌	13° 48′ 43″	*B.*	32° 13′ 47″	*B.*	47° 54′ 23″	136° 27′ 8″	
December 27	$12^h\ 48^m\ 15^s$ *m.*	24° 50′ 30″		13° 38′ 48″		32° 10′ 40″		48° 24′ 25″	136° 53′ 34″	
	$12^h\ 55^m\ 15^s$ *m.*	24° 7′ 0″		14° 11′ 39″		32° 33′ 22″		47° 36′ 35″	136° 10′ 6″	

Year 1652; day	Corrected time	Longitude	Sign	Latitude	Mark	Declination	Mark	Right ascension	Distance of the comet from the Sun	
	1h 24m 45s m.	24° 10′ 12″	♑	14° 41′ 24″	B.	33° 2′ 53″	B.	47° 30′ 16″	136° 3′ 54″	
	2h 6m 0s m.	24° 17′ 39″		13° 53′ 14″		32° 18′ 30″		47° 54′ 24″	136° 22′ 0″	From the distances
	5h 14m 5s v.	23° 15′ 27″		16° 1′ 22″		34° 4′ 34″		46° 2′ 20″	134° 13′ 40″	
	5h 19m [?] v.	23° 34′ 58″	♑	16° 2′ 31″	B.	34° 11′ 11″	B.	46° 23′ 32″	134° 31′ 2″	
	5h 23m 58s v.	23° 39′ 26″		16° 13′ 43″		34° 23′ 14″		46° 24′ 41″	134° 31′ 52″	
	5h 33m 39s v.	23° 58′ 30″		16° 5′ 34″		34° 20′ 24″		46° 48′ 53″	134° 51′ 20″	
	5h 38m 10s v.	23° 58′ 10″	♑	16° 11′ 56″	B.	34° 26′ 28″	B.	46° 46′ 18″	134° 47′ 54″	From the distances
	5h 40m 48s v.	23° 52′ 20″		16° 12′ 25″		34° 25′ 11″		46° 39′ 42″	134° 43′ 24″	
	5h 50m 9s v.	23° 34′ 26″		16° 21′ 14″		34° 27′ 56″		46° 17′ 14″	134° 24′ 10″	
	11h 44m 31s v.	23° 23′ 24″	♑	17° 5′ 57″	B.	35° 8′ 36″	B.	45° 48′ 34″	133° 47′ 32″	
	11h 52m 31s v.	23° 13′ 36″		17° 1′ 32″		35° 1′ 33″		45° 39′ 13″	133° 39′ 8″	
December 28	12h 13m 46s m	23° 14′ 19″		17° 6′ 7″		35° 5′ 50″		45° 38′ 35″	133° 38′ 36″	
	1h 34m 10s m.	23° 24′ 58″	♑	17° 10′ 50″	B.	35° 13′ 41″	B.	45° 48′ 28″	133° 42′ 48″	From the distances
December 29	3h 50m 52s m.	21° 40′ 33″		20° 20′ 28″		37° 44′ 37″		42° 40′ 10″	130° 10′ 20″	
	3h 55m 52s m.	21° 25′ 58″		20° 13′ 28″		37° 33′ 41″		42° 26′ 26″	129° 59′ 15″	
	4h 5m 50s m.	22° 32′ 39″	♑	19° 55′ 21″	B.	37° 35′ 50″	B.	43° 47′ 38″	131° 2′ 15″	From the distances
	4h 28m 50s m.	22° 56′ 37″		19° 23′ 14″		37° 12′ 8″		44° 27′ 52″	131° 34′ 42″	
	4h 47m 49s m.	21° 28′ 3″		20° 7′ 37″		37° 28′ 45″		42° 31′ 3″	130° 0′ 57″	
	5h 0m 0s m.	22° 21′ 33″	♑	20° 32′ 44″	B.	38° 8′ 17″	B.	43° 21′ 26″	130° 39′ 17″	From the distances
December 30	6h 10m 30s v.	21° 27′ 48″		23° 23′ 17″		40° 33′ 40″		41° 10′ 12″	127° 34′ 0″	From the distances
December 31	3h 37m 26s m.	21° 14′ 22″		23° 58′ 19″		41° 3′ 7″		40° 39′ 35″	126° 50′ 5″	
	3h 44m 24s m.	21° 18′ 48″	♑	23° 48′ 51″	B.	40° 55′ 28″	B.	40° 48′ 49″	126° 56′ 51″	
	4h 7m 18s m.	21° 28′ 40″		24° 3′ 3″		41° 11′ 51″		40° 54′ 0″	126° 59′ 20″	From the distances

Year 1652; day	Corrected time	Longitude	Sign	Latitude	Mark	Declination	Mark	Right ascension	Distance of the comet from the Sun	
Year 1653	$4^h\ 27^m$ *m.*	22^s	21° 4′ 0″		24° 16′ 40″		41° 17′ 20″	40° 19′ 35″	126° 33′ 19″	
January 1	$2^h\ 15^m$ *m.*	40^s	21° 14′ 12″		25° 31′ 57″	*B.*	42° 32′ 52″	39° 55′ 35″	125° 28′ 45″	
	$2^h\ 20^m$ *m.*	43^s	20° 59′ 47″		25° 43′ 53″		42° 38′ 0″	39° 35′ 12″	125° 12′ 23″	
	$2^h\ 24^m$ *m.*	55^s	20° 53′ 10″		25° 50′ 48″		42° 42′ 30″	39° 24′ 53″	125° 4′ 19″	
	$2^h\ 52^m$ *m.*	49^s	20° 55′ 29″		25° 44′ 48″	*B.*	42° 38′ 23″	39° 28′ 58″	125° 7′ 20″	From the distances
	$3^h\ 3^m$ *m.*	48^s	20° 56′ 21″		25° 46′ 12″		42° 39′ 12″	39° 30′ 13″	125° 7′ 7″	From the distances
	$3^h\ 3^m$ *m.*	48^s	20° 55′ 24″		25° 44′ 25″				125° 6′ 56″	From the distances
	$3^h\ 26^m$ *m.*	0^s	20° 44′ 49″		25° 49′ 51″	*B.*	42° 39′ 0″	39° 15′ 8″	124° 55′ 16″	
	$3^h\ 44^m$ *m.*	16^s	20° 43′ 42″		25° 49′ 58″		42° 38′ 50″	39° 13′ 58″	124° 53′ 40″	
January 2	$6^h\ 27^m$ *v.*	30^s	20° 28′ 0″		27° 9′ 0″		43° 48′ 4″	38° 18′ 7″	122° 51′ 24″	From the distances
January 3	$6^h\ 47^m$ *v.*	30^s	20° 10′ 48″		29° 2′ 40″	*B*	45° 28′ 42″	37° 1′ 0″	121° 6′ 34″	From the distances
January 4	$2^h\ 3^m$ *m.*	24^s	19° 42′ 7″		29° 30′ 46″		45° 45′ 44″	36° 13′ 0″	120° 18′ 23″	From the distances
	$2^h\ 39^m$ *m.*	10^s	19° 12′ 17″		30° 14′ 15″		46° 16′ 26″	35° 15′ 2″	119° 38′ 26″	
	$2^h\ 53^m$ *m.*	30^s	20° 30′ 12″		29° 5′ 1″	*B.*	45° 37′ 14″	37° 22′ 12″	121° 4′ 37″	
January 7	$2^h\ 26^m$ *m.*	9^s	19° 41′ 56″		31° 50′ 26″		47° 55′ 0″	34° 56′ 0″	117° 2′ 42″	From the distances
	$2^h\ 41^m$ *m.*	0^s	19° 27′ 23″		31° 55′ 36″		47° 55′ 3″	34° 35′ 54″	116° 48′ 49″	

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[188] the table is framed and ruled; a rule stands under the headings and under every third row. The first column is headed with the year 1652 and "Die" (day), the time column "corrected time" in hours, minutes and seconds, and each angle column in degrees, minutes and seconds. The last column carries no heading; "From the distances" renders its entry "Ex diſtant.". In the time column *v.* and *m.* stand after the figures. The sign column stands beside the longitude, marked by the "S." of its heading "Gr Min Sec.S."; each sign and each latitude and declination mark is printed only in some rows, as shown, and a blank sign or mark cell is blank on the page. The declination and right ascension of the second observation at $3^h\ 3^m\ 48^s$ on January 1 are blank on the page. The year 1653 is printed in the first column of the last December 31 row.

Section IX. To Investigate the Comet's Proper and Daily Motion, both the Relation It Held to the Equator, or the Angle between the Equator and the Comet's Orbit, and the Node, or Point of Intersection with the Equator [SECTIO IX. Motum Cometæ proprium & diurnum, tùm rationem, quàm ad Æquatorem obtinuerit, ſive angulum Æquatoris & Orbitæ Cometalis, tùm Nodùm, ſeu punctum interſectionis Æquatoris indagare.]

From the calculation carried out above at length and with care, it is very clear that our comet continually changed not only its declinations and right ascensions with respect to the equator, but also its longitudes and latitudes with respect to the ecliptic. It did so in such a way that in longitude it advanced gradually, against the order of the signs, while in latitude it advanced with a fairly swift motion, roughly towards the north, crossing the equator and the ecliptic at a certain angle of inclination.

[Margin: Cometa motui proprio obnoxius fuit.] (The comet was subject to a proper motion.)

Since it is therefore more than certain that the comet had a proper motion [motus proprius] in a particular orbit, it will also be our task to examine that motion — both the angle between the comet's orbit and the equator and the point of their intersection — with the utmost diligence, as is fitting. Before we come to that, however, we shall first set out the demonstration and the method of the calculation, so that afterwards it will be necessary to give only the bare calculation. From which observations, and in what order, we sought the daily motion, the calculation itself will show.

[Margin: Ex quibus obſervationibus motus proprius nec non angulus orbitæ exquiſitùs eruatur?] (From which observations are the proper motion and also the angle of the orbit derived most precisely?)

We have taken care that the comet's proper motion, the angle of the orbit and the point of intersection should be derived from observations and from more distant places of the comet (from which this can be done far more certainly): above all, that is, from the observation made on December 20, the first day of the apparition, at about 7 in the evening, when the comet formed an equilateral triangle with fixed stars. For from places separated from one another by no notable distance, all these quantities are computed hardly accurately enough, because the angles are too acute.

In the figure shown here, let ACEBD be the meridian, AB the equator, E its pole, EI, EK and EL circles of declination, and DHC the comet's orbit, intersecting the equator at H. Let M be the comet's place on December 20, and G its place on December 23, so that LM and IG are the comet's declinations, and AI and AL the right ascensions. With the diagram drawn in this way, MG is the proper motion that the comet completed in its orbit within the space of those days, namely from December 20 to December 23; MHL, or IHG, is the angle between the comet's orbit and the ecliptic; and H is the point of intersection. These three must now be examined by this method.

Diagram. An engraved figure set beside the text: a circle (the meridian of the text) with E at its top, B at the left and A at the right ends of a line labelled "Equator". A straight line from D at lower left to C at upper right is labelled "Orbit" near D and "of the comet" near C, the two words together reading "orbit of the comet"; on it stand M, H, G and F, in that order from D. From E three curves descend to the equator: one through O and L, labelled "Circle of declination", continuing to M below the equator; one through N to I; and one through F to K, labelled "Circle of declination" (its two words set one above the other along the curve). Dotted lines join N to F and O to G. At the lower right, outside the circle, is the engraver's signature "Autor Sculps." (the author engraved it).

- E (top of the circle): point
- C (upper right, on the circle): point
- N (on the curve from E to I): point
- F (on the orbit line and the curve from E to K): point
- O (on the curve from E to L): point
- G (on the orbit line and the curve from E to I): point
- B (left end of the equator line): point
- A (right end of the equator line): point
- L (on the equator line, left): point
- H (on the equator line, where the orbit line crosses it): point
- I (on the equator line, centre): point
- K (on the equator line, right of I): point
- M (on the orbit line, below the equator): point
- D (lower left, on the circle): point
- *Circ. Declinat.* (along the curve E–O–L–M): circle of declination
- *Declin* and *Circul.* (along the curve E–F–K, upper and lower): circle of declination
- *Cometæ.* and *Orbita* (along the line D–C, upper and lower): orbit of the comet
- *Æquator.* (below the equator line, right of K): equator
- *Autor Sculps.* (lower right): the author engraved it

1. In the triangle EGO, right-angled at O, let the perpendicular GO be sought from IL, the difference of the comet's right ascensions, which determines the angle E, and from EG, the complement of the comet's declination at the later station, by this rule: the sum of the logarithms of the two given quantities is the logarithm of the side sought.
2. In the same triangle, from the same hypotenuse and the perpendicular just found, you will find the third side EO. That is, if you subtract the antilogarithm of GO from the antilogarithm of EG, the remainder will be the antilogarithm of the side EO sought. Taking EO from EM, the comet's distance from the pole at the observation [phænomeni] of December 20, you will have OM.

3. Now in the smaller triangle GOM let the hypotenuse GM be computed — that is, the comet's proper motion between December 20 and 23 — the two sides about the right angle, GO and MO, being given. Accordingly, the sum of the antilogarithms of the two sides will be the antilogarithm of the proper motion MG.

[Margin: Ratio calculi pro ſupputando motu proprio.] (Method of calculation for computing the proper motion.)

4. In the triangle MOG just mentioned, let the angle HML likewise be found, the two sides GO and MG being given: subtracting the logarithm of the hypotenuse GM from the logarithm of the side GO, there will remain the logarithm of the angle HML sought.
5. To find the angle between the orbit and the equator, there are given in the triangle LMH the comet's latitude LM on December 20 and the angle HML found above. From these the angle LHM, or IHG, is derived, which as a vertical angle is equal to the former, by Theorem 8, Proposition 15, of Book I of Euclid (Euclid, *Elements* I.15). That is, if you add the logarithm of HML to the antilogarithm of LM, the latitude, the antilogarithm of the angle LHM, or IHG, sought will result.
6. Finally, to compute the point of intersection H, that is, of the orbit and the equator: in the triangle MLH there are given the angle MHL just found and the comet's latitude LM. Let the side HL therefore be found in this way: the sum (algebraic [cosſica], if need be) of the logarithm of the side LM and the mesologarithm of the angle HML is the mesologarithm of the side HL sought. In this case this side is subtracted from the comet's right ascension L of the 20th, so as to obtain the point H, as is clear from the preceding diagram and from the following calculation.

Calculation of the daily motion, of the angle between the comet's orbit and the equator, and also of their point of intersection.

1.

On December 20, at 7^{h} in the evening. — On December 26, at 9^{h} 0^{m} 34^{s} *v.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	31° 55′ 29″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	58° 4′ 31″	GE

Line	Points	Value	Logarithm	Mark
Right ascension of the comet on December 20	AL	71° 21′ 14″		
Right ascension of the comet on December 26	AI	48° 23′ 24″		
Difference IL, or angle IEL		22° 57′ 50″		
Log. of the complement of the declination	EG		16400	
Log. of the angle	IEL		94119	*A.*
Log. of the perpendicular	GO	19° 20′ 19″	110519	

Line	Points	Value	Logarithm	Mark
Antil. of the complement of the declination	EG		63714	
Antil. of the perpendicular	GO		5807	*S.*
Antilog.	EO	55° 54′ 56″	57907	
Distance of the comet from the pole	EM	98° 41′ 14″		
Side	OM	42° 46′ 55″		

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Line	Points	Loga-rithm	Mark	Value	Note
Antil.	OM	30930			
Antil. of the perpendicular	GO	5807	*A.*		
Antil.	GM	36737		46° 10′ 2″	proper motion
Log. of the perpendicular	GO	110519			
Log.	GM	32661	*S.*		
Log. of the angle	HML	77858		27° 19′ 36″	
Antil.	LM	1154			
Log. of the angle	HML	77858	*A.*		
Antil. of the angle	LHM	79012		63° 0′ 44″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	66024	+ *A.*		
Mesolog.	HL	255044	+	4° 27′ 45″	HL
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 53′ 29″	

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2.

On December 20, at 7^{h} in the evening. — On December 28, at 1^{h} 34^{m} 10^{s} *m.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B*	35° 13′ 41″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	54° 46′ 19″	GE

[189] left column of the calculation. On the page the two dated captions stand side by side over the first two lines, which carry the two stations' values side by side, as set above. The angle values stand in one column at the right of the logarithms; the value of GO, 19° 20′ 19″, is printed on the line of its logarithm. A row of degree, minute and second marks stands over the antilogarithm line of EO. Rules stand under the right ascension of December 26, under the log. of the angle IEL, under the antil. of GO, and under the distance EM.

[190] right column of the calculation. The notes "motus prop." (proper motion) and "Orb. & Æquat." (orbit and equator) each run over two lines at the right, beginning on the line shown. Rules stand under the antil. of GO, under the log. of GM, under the second log. of the angle HML, under the mesolog. of HML, and under the right ascension of December 20.

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on December 28	AI			45° 48′ 28″	
Difference IL, or angle IEL				25° 32′ 46″	
Log. of the complement of the declination	EG	20229			
Log. of the angle	IEL	84110	*A.*		
Log. of the perpendicular	GO	104339		20° 37′ 32″	
Antil. of the complement of the declination	EG	55020			
Antil. of the perpendicular	GO	6624	*S.*		
Antilog.	EO	48396		51° 57′ 3″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antil. *lat.*	OM	37781		46° 44′ 11″	
Antil. of the perpendicular	GO	6624	*A.*		
Antil.	GM	44405		50° 6′ 6″	proper motion
Log. of the perpendicular	GO	104339			
Log.	GM	26503	*S.*		
Log. of the angle	HML	77836		27° 20′ 0″	
Antil.	LM	1154	*A.*		
Antil. of the angle	LHM	78990		63° 0′ 22″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	65995	+ *A.*		
Mesolog.	HL	255015	+	4° 27′ 49″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 53′ 25″	

3.

On December 20, at 7^h in the evening. — On December 29, at 4^h 5^m 50^s

Line	Value	Points	Line	Value	Points
Declination of the comet, *A*	8° 41′ 14″	LM	Declination of the comet, *B.*	37° 35′ 50″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	52° 24′ 10″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on December 29	AI			43° 47′ 38″	
Difference IL, or angle IEL				27° 33′ 36″	
Log. of the complement of the declination	EG	23279			
Log. of the angle	IEL	77074	*A.*		
Log. of the perpendicular	GO	100353		21° 30′ 19″	

Line	Points	Logarithm	Mark	Value	Note
Antil. of the complement of the declination	EC [recte: EG]	49413			
Antil. of the perpendicular	GO	7216	*S.*		
Antil.	EO	42197		49° 1′ 22″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antilog.	OM	43502		49° 39′ 52″	
Antil. of the perpendicular	GO	7216	*A.*		
Antilog.	GM	50718		52° 58′ 25″	proper motion
Log. of the perpendicular	GO	100353			
Log.	GM	22519	*S.*		
Log. of the angle	HML	77834		27° 20′ 0″	
Antil.	LM	1154	*A.*		
Antil. of the angle	LHM	78988		63° 0′ 20″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	65995	+ *A.*		
Mesolog.	HL	255015	+	4° 27′ 50″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 53′ 24″	

4.

On December 20, at 7^h in the evening. — On December 30, at 6^h 10^m 30^s

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	40° 33′ 40″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	49° 26′ 20″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on December 30	AI			41° 10′ 12″	
Difference IL, or angle IEL				30° 11′ 2″	
Log. of the complement of the declination	EG	27482			
Log. of the angle	IEL	68760	*A.*		
Log. of the perpendicular	GO	96242		22° 27′ 20″	
Antil. of the complement of the declination	EG	43039			
Antil. of the perpendicular	GO	7885	*S.*		
Antil.	EO	35154		45° 17′ 0″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antil. *lat.*	OM	51734		53° 24′ 14″	
Antil. of the perpendicular	GO	7885	*A.*		
Antil.	GM	59619		56° 34′ 16″	proper motion

Line	Points	Logarithm	Mark	Value	Note
Log. of the perpendicular	GO	96242			
Log.	GM	18084	*S.*		
Log. of the angle	HML	78158		27° 14′ 17″	
Antilog.	LM	1154	*A.*		
Antil. of the angle	LHM	79312		63° 6′ 1″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	66404	+ *A.*		
Mesolog.	HL	255424	+	4° 26′ 45″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 54′ 29″	

5.
On December 20, at 7^h in the evening. — On December 31, at 4^h 7^m 18^s

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	41° 11′ 51″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	48° 48′ 9″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on December 31	AI			40° 54′ 0″	
Difference IL, or angle IEL				30° 27′ 14″	
Log. of the complement of the declination	GE	28443			
Log. of the angle	IEL	67956	*A.*		
Log. of the perpendicular	GO	96399		22° 25′ 6″	
Antil. of the complement of the declination	GE	41755			
Antil. of the perpendicular	GO	7858	*S.*		
Antil.	EO	33897		44° 33′ 38″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antilog. *lat.*	OM	53445		54° 7′ 36″	
Antil. of the perpendicular	GO	7858	*A.*		
Antil.	GM	61303		57° 12′ 0″	proper motion
Log. of the perpendicular	GO	96399			
Log.	GM	17368	*S.*		
Log. of the angle	HML	79031		26° 58′ 51″	
Antilog.	LM	1154	*A.*		
Antilog.	LHM	80185		63° 21′ 9″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	67510	+ *A.*		
Mesolog.	HL	256530	+	4° 23′ 50″	

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 57′ 24″	

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6.
On December 20, at 7^h in the evening. — On January 1, at 2^h 52^m 49^s *m.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	42° 38′ 20″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	47° 21′ 40″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on January 1	AI			39° 28′ 58″	
Difference IL, or angle IEL				31° 52′ 16″	
Log. of the complement of the declination	EG	30704			
Log. of the angle	IEL	63863	*A.*		
Log. of the perpendicular	GO	94567		22° 51′ 21″	
Antil. of the complement of the declination	EG	38952			
Antil. of the perpendicular	GO	8177	*S.*		
Antilog.	EO	30775		42° 41′ 5″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antil. *lat.*	OM	58132		56° 0′ 9″	
Antil. of the perpendicular	GO	8177	*A.*		
Antil.	GM	66309		58° 59′ 5″	proper motion
Log. of the perpendicular	GO	94567			
Log.	GM	15429	*S.*		
Log. of the angle	HML	79138		26° 57′ 1″	
Antil.	LM	1154	*A.*		
Antil. of the angle	LHM	80292		63° 23′ 0″	orbit and equator

[191] the page is set in two columns, each holding two calculations one above the other: 2 above 3 at the left, 4 above 5 at the right. In each, the two dated captions stand side by side over the first two lines, which carry the two stations' values side by side, as set above; the notes "motus prop." (proper motion; "motus propr." in calculation 4) and "Orb. & Æquat." (orbit and equator) each run over two lines at the right, beginning on the line shown. Rules stand under the right ascension of the second station, under the log. of the angle IEL, under the first antil. of GO, under the distance EM, under the second antil. of GO, under the log. of GM, under the antil. of LM, under the mesolog. of HML, and under the right ascension of December 20. In calculation 5 the first declination is printed "8 41′ 14″", the degree mark after 8 not settled. The lower part of the page is blank.

Line	Points	Logarithm	Mark	Value	Note
Log.	LM	189020	+		
Mesolog.	HML	67642	+ *A.*		
Mesolog.	HL	256662	+	4° 23′ 29″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 57′ 45″	

7.
On December 20, at 7^h in the evening. — On January 2, at 6^h 27^m 30^s

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	43° 48′ 4″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	46° 11′ 56″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on January 2	AI			38° 18′ 7″	
Difference IL, or angle IEL				33° 3′ 7″	
Log. of the complement of the declination	EG	32606			
Log. of the angle	IEL	60624	*A.*		
Log. of the perpendicular	GO	93230		23° 10′ 55″	
Antil. of the complement of the declination	EG	36749			
Antil. of the perpendicular	GO	8418	*S.*		
Antil.	EO	28331		41° 7′ 25″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antilog.	OM	62296		57° 33′ 49″	
Antil. of the perpendicular	GO	8418	*A.*		
Antilog.	GM	70714		60° 27′ 30″	proper motion
Log. of the perpendicular	GO	93230			
Log.	GM	13926	*S.*		
Log. of the angle	HML	79304		26° 54′ 7″	
Antil.	LM	1154	*A.*		
Antil. of the angle	LHM	80458		63° 25′ 50″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	67867	+ *A.*		
Mesolog.	HL	256887	+	4° 22′ 50″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 58′ 24″	

8.
On December 20, at 7^h in the evening. — On January 3, at 6^h 47^m 30^s

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	45° 28′ 46″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	44° 31′ 14″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on January 3	AI			37° 1′ 0″	
Difference IL, or angle IEL				34° 20′ 14″	
Log. of the complement of the declination	EG	35501			
Log. of the angle	IEL	57259	*A.*		
Log. of the perpendicular	GO	92760		23° 17′ 42″	
Antil. of the complement of the declination	EG	33828			
Antil. of the perpendicular	GO	8503	*S.*		
Antil.	EO	25325		39° 4′ 45″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antil. *lat.*	OM	68138		59° 36′ 29″	
Antil. of the perpendicular	GO	8503	*A.*		
Antil.	GM	76641		62° 18′ 39″	proper motion
Log. of the perpendicular	GO	92760			
Log.	GM	12160	*S.*		
Log. of the angle	HML	80600		26° 31′ 41″	
Antilog.	LM	1154	*A.*		
Antil. of the angle	LHM	81754		63° 47′ 58″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	69477	+ *A.*		
Mesolog.	HL	258497	+	4° 18′ 42″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			67° 2′ 32″	

9.
On December 20, at 7^h in the evening. — On January 4, at 2^h 3^m 24^s

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	45° 45′ 44″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	44° 14′ 16″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on January 4	AI			36° 13′ 0″	
Difference IL, or angle IEL				35° 8′ 14″	

Line	Points	Logarithm	Mark	Value	Note
Log. of the complement of the declination	GE	36005			
Log. of the angle	IEL	55245	*A.*		
Log. of the perpendicular	GO	91250		23° 40′ 24″	
Antil. of the complement of the declination	GE	33345			
Antil. of the perpendicular	GO	8790	*S.*		
Antil.	EO	24555		38° 32′ 10″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antilog. *lat.*	OM	69772		60° 9′ 4″	
Antil. of the perpendicular	GO	8790	*A.*		
Antil.	GM	78562		62° 52′ 53″	proper motion
Log. of the perpendicular	GO	91250			
Log.	GM	11649	*S.*		
Log. of the angle	HML	79601		26° 48′ 55″	
Antilog.	LM	1154	*A.*		
Antilog.	LHM	80755		63° 30′ 57″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	68227	+ *A.*		
Mesolog.	HL	257247	+	4° 21′ 57″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 59′ 17″	

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10.
On December 20, at 7^h in the evening. — On January 7, at 2^h 26^m 9^s *m.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	47° 55′ 0″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	42° 5′ 0″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on January 7	AI			34° 56′ 0″	
Difference IL, or angle IEL				36° 25′ 14″	
Log. of the complement of the declination	GE	40016			
Log. of the angle	IEL	52136	*A.*		
Log. of the perpendicular	GO	92152		23° 26′ 53″	

[192] the page is set in two columns, each holding two calculations one above the other: 6 above 7 at the left, 8 above 9 at the right, so that 8 stands beside 6; they are given here in their numbered order. Each is laid out as the calculations of p. 133, with the same rules; the note "motus prop." reads "motus propr." in calculation 8. In calculation 9 the first declination is printed "8 41′ 14″", with no degree mark. The lower part of the page is blank.

Line	Points	Loga-rithm	Mark	Value	Note
Antil. of the complement of the declination	GE	29818			
Antil. of the perpendicular	GO	8619	*S.*		
Antil.	EO	21199		36° 0′ 15″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antil. *lat.*	OM	77890		62° 40′ 59″	
Antil. of the perpendicular	GO	8619	*A.*		
Antil.	GM	86509		65° 6′ 5″	proper motion
Log. of the perpendicular	GO	92152			
Logarithm	GM	9755	*S.*		
Log. of the angle	HML	82397		26° 1′ 12″	
Antil.	LM	1154	*A.*		
Antil.	LHM	83551		64° 18′ 1″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	71711	+ *A.*		
Mesolog.	HL	260731	+	4° 13′ 1″	*S.*
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			67° 8′ 13″	

11.

On December 20, at 7^h in the evening. — On December 23, at 10^h 57^m 20^s *v.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	18° 18′ 51″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	71° 41′ 9″	GE

Line	Points	Loga-rithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on December 23	AI			57° 11′ 27″	
Difference IL, or angle IEL				14° 9′ 47″	
Long. [recte: Log.] of the complement of the declination	GE	5198			
Long. [recte: Log.] of the angle	IEL	140781	*A.*		
Log. of the perpendicular	GO	145979		13° 25′ 54″	
Antil. of the complement of the declination	GE	115764			
Antil. of the perpendicular	GO	2773	*S.*		
Antil.	EO	112991		71° 9′ 7″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antilog. *lat.*	OM	12022		27° 32′ 7″	
Antil. of the perpendicular	GO	2773	*A.*		
Antil.	GM	14795		30° 24′ 17″	proper motion
Log. of the perpendicular	GO	145979			
Logarithm	GM	68101	*S.*		

Line	Points	Logarithm	Mark	Value	Note
Log. of the angle	HML	77878		27° 19′ 13″	
Antil.	LM	1154	*A.*		
Antil. of the angle	LHM	79032		63° 1′ 7″	orbit and equator
Logarithm	LM	189020	+		
Mesolog.	HML	66051	+ *A.*		
Mesolog.	HL	255071	+	4° 27′ 41″	*S.*
Longitude of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 53′ 33″	

12.

On December 20, at 7^h in the evening. — On December 26, at 11^h 33^m 22^s *v.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	32° 11′ 35″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	57° 48′ 25″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20				71° 21′ 14″	
Right ascension of the comet on December 26				48° 16′ 9″	
Difference IL, or angle IEL				23° 5′ 5″	
Log. of the complement of the declination	GE	16694			
Log. of the angle	IEL	93627	*A.*		
Log. of the perpendicular	GO	110321		19° 22′ 41″	
Antil. of the complement of the declination	GE	62967			
Antil. of the perpendicular	GO	5832	*S.*		
Antil.	EO	57135		55° 36′ 51″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antil. *lat.*	OM	31405		43° 4′ 23″	
Antil. of the perpendicular	GO	5832	*A.*		
Antil.	GM	37237		46° 26′ 28″	proper motion
Log. of the perpendicular	GO	110321			
Log.	GM	32203	*S.*		
Log. of the angle	HML	78118		27° 15′ 0″	
Antil.	LM	1154	*A.*		
Antil. of the angle	LHM	79272		63° 5′ 18″	orbit and equator
Logarithm	LM	189020	+		
Mesolog.	HML	66352	+ *A.*		
Mofolog. [recte: Mesolog.]	HL	255372	+	4° 26′ 53″	*S.*
Longitude of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 54′ 21″	

13.

On December 20, at 7^h in the evening. — On December 31, at 3^h 44^m 24^s *m.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B*	40° 55′ 28″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	49° 4′ 32″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on December 31	AI			40° 48′ 49″	
Difference IL, or angle IEL				30° 32′ 25″	
Log. of the complement of the declination	GE	28028			
Log. of the angle	IEL	67700	*A.*		
Log. of the perpendicular	GO	95728		22° 34′ 38″	
Antil. of the complement of the declination	GE	42303			
Antil. of the perpendicular	GO	7974	*S.*		
Antil.	EO	34329		44° 48′ 40″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antilog. *lat.*	OM	52844		53° 52′ 34″	
Antil. of the perpendicular	GO	7974	*A.*		
Antil.	GM	60818		57° 1′ 14″	proper motion
Log. of the perpendicular	GO	95728			
Log.	GM	17571	*S.*		
Log. of the angle	HML	78157		27° 14′ 18″	
Antil.	LM	1154	*A.*		
Antil. of the angle	LHM	79311		63° 6′ 0″	orbit and equator
Logarithm	LM	189020	+		
Mesolog.	HML	66402	+ *A.*		
Mesolog.	HL	255422	+	4° 26′ 46″	*S.*
Longitude of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 54′ 28″	

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[193] the page is set in two columns, each holding two calculations one above the other: 10 above 11 at the left, 12 above 13 at the right. Each is laid out as the calculations of pp. 133–134, with the same rules; the notes read "motus proprius" (proper motion) and "Orbitæ & Æquat." or "Orb. & Æquat." (orbit and equator). On the mesolog. of HL each calculation here prints a mark "S." after the figures, not printed on that line on pp. 133–134. In calculations 11–13 the line of the right ascension of December 20 is headed "Longit." (longitude) in its second use, at the foot. In calculation 12 the two right ascensions carry no point letters, and the second figure of the minutes in the time of December 26 is read as 3 (an old-style 3, descending below the line), although the table on p. 136 prints the time of this observation as 11^h 38^m 22^s. The lower part of the page is blank.

14.
On December 20, at 7^h in the evening. — On January 1, at 3^h 26^m 0^s *m.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B*	42° 39′ 0″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	47° 21′ 0″	GE

Line	Points	Logarithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on January 1	AI			39° 15′ 8″	
Difference IL, or angle IEL				32° 6′ 6″	
Log. of the complement of the declination	EG	30720			
Log. of the angle	IEL	63219	*A.*		
Log. of the perpendicular	GO	93939		23° 0′ 30″	
Antil. of the complement of the declination	EG	38932			
Antil. of the perpendicular	GO	8289	*S.*		
Antilog.	EO	30643		42° 36′ 10″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antil. *lat.*	OM	58345		56° 5′ 4″	
Antil. of the perpendicular	GO	8289	*A.*		
Antil.	GM	66634		59° 5′ 50″	proper motion
Log. of the perpendicular	GO	93939			
Log.	GM	15310	*S.*		
Log. of the angle	HML	78629		27° 5′ 57″	
Antil.	LM	1154	*A.*		
Antil. of the angle	LHM	79783		63° 14′ 12″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	67001	+ *A.*		
Mesolog.	HL	256021	+	4° 25′ 10″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 56′ 4″	

15.
On December 20, at 7^h in the evening. — On January 4, at 2^h 39^m 10^s *m.*

Line	Value	Points	Line	Value	Points
Declination of the comet, *A.*	8° 41′ 14″	LM	Declination of the comet, *B.*	46° 16′ 26″	GI
Distance from the pole	98° 41′ 14″	EM	Complement	43° 43′ 34″	GE

Line	Points	Loga-rithm	Mark	Value	Note
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Right ascension of the comet on January 4	AI			35° 15′ 2″	
Difference IL, or angle IEL				36° 6′ 12″	
Log. of the complement of the declination	EG	36931			
Log. of the angle	IEL	52892	*A.*		
Log. of the perpendicular	GO	89823		24° 2′ 5″	
Antil. of the complement of the declination	EG	32484			
Antil. of the perpendicular	GO	9069	*S.*		
Antil.	EO	23415		37° 41′ 50″	
Distance of the comet from the pole	EM			98° 41′ 14″	
Antil. *lat.*	OM	72369		60° 59′ 24″	
Antil. of the perpendicular	GO	9069	*A.*		
Antil.	GM	81438		63° 42′ 36″	proper motion
Log. of the perpendicular	GO	89823			
Log.	GM	10920	*S.*		
Log. of the angle	HML	78903		27° 1′ 7″	
Antilog.	LM	1154	*A.*		
Antil. of the angle	LHM	80057		63° 18′ 55″	orbit and equator
Log.	LM	189020	+		
Mesolog.	HML	67348	+ *A.*		
Mesolog.	HL	256368	+	4° 24′ 15″	
Right ascension of the comet on December 20	AL			71° 21′ 14″	
Point of intersection with the equator	H			66° 56′ 59″	

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Why, my reader, did we see fit to investigate, so many times, both the angle between the equator and the comet's orbit and the point of intersection? And how large, moreover, was that angle in fact at that time? Since the calculations do not wholly agree with one another, we shall say in the next Section. At this point nothing more remains to be added except how large the comet's daily motion was, found from entirely different observations — namely, those made by altitudes and azimuths — so that that motion may likewise be explored the more surely, and also so that the proper motion found above by means of the distances may, as it were, be tested by it. For brevity's sake, however, let us omit the calculation itself, and only indicate, and show in a small table, from which observations and which data it was derived, and how large it came out. For everything was investigated by exactly the same method as before, except that in these examples both declinations were northern, namely IG and KF, as is

[194] the two calculations stand side by side at the head of the page, 14 at the left and 15 at the right, each laid out as the calculations of pp. 133–135, with the same rules; the note "motus prop." reads "motus propr." in calculation 15. Neither prints the mark "S." after the figures on the mesolog. of HL.

clear from the figure above, so that the proper motion is GF, and the difference of the right ascensions KI.

[Margin: Majoris certitudinis gratiâ, ex diverſis aliis obſervationibus motus Cometæ proprius exploratus eſt.] (For greater certainty, the comet's proper motion has been explored from various other observations.)

Day	Month	Time by the corrected clock	Declination	Right ascension	Proper motion
23	December	$10^h\ 57^m\ 20^s$ *v.*	18° 18′ 51″ *B.*	57° 11′ 27″	16° 2′ 15″
26	December	$11^h\ 38^m\ 22^s$ *v.*	32° 11′ 35″ *B.*	48° 16′ 9″	
23	December	$10^h\ 57^m\ 20^s$ *v.*	18° 18′ 51″ *B.*	57° 11′ 27″	19° 37′ 33″
27	December	$11^h\ 44^m\ 31^s$ *v.*	35° 8′ 36″ *B.*	45° 48′ 34″	
23	December	$10^h\ 57^m\ 20^s$ *v.*	18° 18′ 51″ *B.*	57° 11′ 27″	19° 41′ 48″
28	December	$1^h\ 34^m\ 10^s$ *m.*	35° 13′ 41″ *B.*	45° 48′ 28″	
23	December	$10^h\ 57^m\ 20^s$ *v.*	18° 18′ 51″ *B.*	57° 11′ 27″	26° 9′ 45″
30	December	$6^h\ 10^m\ 30^s$ *v.*	40° 33′ 40″ *B.*	41° 10′ 12″	
23	December	$10^h\ 57^m\ 20^s$ *v.*	18° 18′ 51″ *B.*	57° 11′ 27″	26° 45′ 40″
31	December	$3^h\ 44^m\ 24^s$ *m.*	40° 55′ 28″ *B.*	40° 48′ 49″	
23	December	$10^h\ 57^m\ 20^s$ *v.*	18° 18′ 51″ *B.*	57° 11′ 27″	30° 1′ 20″
2	January	$6^h\ 27^m\ 30^s$ *v.*	43° 48′ 4″ *B.*	38° 18′ 7″	

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[195] the table is ruled in a double frame. Its group heads are "Obſervationes." (observations) over the day, month and time, "Data." over the declination and right ascension, and "Quæſita." (sought) over the proper motion; the time column is headed "Sec. Horol.corr." (by the corrected clock), with "Hor.Min. Sec." under it, and the declination and right ascension "Gr.Min.Sec.". The rows stand in pairs, each the observation of December 23 and a later one; a brace joins the two right ascensions of each pair, and the proper motion of each pair is set once, centred between its two rows (given here on the first row). In the third pair the first declination is followed by "B," with a comma. No labels stand below the last row.

Section X. Given the Comet's Longitudes and Latitudes, to Find Its Proper and Daily Motion, and Also the Relation It Had to the Ecliptic, That Is, the Angle of the Comet's Orbit and the Ecliptic, and Also the Node, or Its Point of Intersection [SECTIO X. Datis Cometæ Longitudinibus & Latitudinibus, motum ejus proprium, & diurnum, tùm rationem quàm ad Eclipticam obtinuerit, ſive angulum orbitæ Cometalis & Eclipticæ, tùm Nodum, ſeu punctum ejus interſectionis indagare.]

Since this calculation rests on exactly the same demonstration and method of computation as the preceding one, and likewise on the rules of logarithms, there is no need to repeat it all again. It will therefore be enough if we add only a description of the accompanying figure, which serves this investigation, and also set briefly before the eyes, as if in a small table, the order in which the triangles are solved. Let ACEBDE, then, be the solstitial colure [colurus Solstitiorum], AB the ecliptic, and E its pole; the arcs descending from E, namely EL, EI and EK, the circles of latitude; DHC the orbit of the comet, so that F, G, G is the comet's place; H the point of intersection with the ecliptic, or node; AL, AI and AK the longitudes; and KF, IG and LG the latitudes; while the angle IHG, or LHG, is the angle of the comet's orbit and the ecliptic, and GF the proper motion.

[Margin: Simili planè ratione Cometæ ſitus ad Eclipticam, ut ad Æquatorem ſupputatur.] (The comet's position with respect to the ecliptic is computed in exactly the same way as with respect to the equator.)

Diagram. An engraved figure set beside the text: a circle, the solstitial colure, labelled "Colurus" inside it at the upper left and "Solstitiorum." along its right side. On the circle stand E at the upper right, C just below and to the right of it, B at the left, D at the lower left, A at the lower right and a second E at the bottom. A straight line from B to A is labelled "Ecliptica." (ecliptic); on it stand K, I and H, in that order from B, and L beyond H. A straight line from D to C is labelled "Orbita" (orbit) near D and "Cometæ." (of the comet) near C; on it stand F, a lower G and an upper G, and it crosses the ecliptic at H. From the upper E a curve labelled "Circ. Latit" (circle of latitude) descends through the upper G to L. From the lower E two curves rise, labelled "Circ. Latit." and "Circ. Latitud." (circle of latitude): one through F to K, the other through N and the lower G to I. A dotted line joins F to N. At the lower right, inside the frame, is the engraver's signature "Autor sculps." (the author engraved it).

- E (upper right, on the circle): point
- C (on the circle, right of E): point
- B (left, on the circle; end of the ecliptic): point
- D (lower left, on the circle; end of the orbit line): point
- A (lower right, on the circle; end of the ecliptic): point
- E (bottom of the circle): point
- K, I, H (on the ecliptic, in order from B): points
- L (on the ecliptic, beyond H): point
- G (upper, on the orbit line and the curve from the upper E): point

- G (lower, on the orbit line and the curve through N): point
- F (on the orbit line and the curve to K): point
- N (on the curve to I, joined to F by a dotted line): point
- *Colurus* and *Solstitiorum.* (inside the circle, upper left and right side): solstitial colure
- *Ecliptica.* (below the ecliptic line, right): ecliptic
- *Orbita* and *Cometæ.* (along the line D–C, lower and upper): orbit of the comet
- *Circ. Latit* (along the curve from the upper E): circle of latitude
- *Circ. Latit.* and *Circ. Latitud.* (along the two curves from the lower E): circle of latitude
- *Autor sculps.* (lower right): the author engraved it

But in what order is the calculation to be undertaken, which triangles are to be solved, from which data, and what is sought? The following small table shows it. It should be noted, however, that in this calculation the comet's longitudes must always be used in place of the right ascensions, and its latitudes in place of the declinations, as is easy to gather. Moreover, since in our first example below both latitudes are southern, the figure takes on an entirely different appearance; and so, as a consequence, entirely different triangles also arise to be solved, as you see.

Right triangles to be solved	Given	Sought
1 Triangle ENF	Angle NEF, difference of longitude IK Side EF, complement of the latitude of the earlier day	perpendicular FN
2 Triangle ENF	Hypotenuse EF, complement of the latitude perpendicular FN, just found	Side EN; when this is subtracted from EG, the complement of the latitude, there remains side NG
3 Triangle GNF	Side NG Side FN, perpendicular	proper motion GF

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[Margin: Compendioſa calculi ratio.] (A short method of calculation.)

Right triangles to be solved	Given	Sought
4 Triangle GNF	Side FN	Angle NGH, or HGI, which is equal to the one found

[196] an unruled scheme: the two lines of given data for each triangle are enclosed in square brackets, and the sought quantity stands to the right of them, centred between the two lines. In the second triangle EN stands over EG with a rule beneath, and NG below the rule.

Right triangles to be solved	Given	Sought
	Hypotenuse FG, or the proper motion	
5 Triangle GIH	Side IG, latitude of the comet on the later day	Angle of the orbit and the ecliptic GHI,
	Angle HGI, just found	to which the vertical angle LHG is equal
6 Triangle GIH	Angle of the orbit and the ecliptic GHI	Side IH
	Side IG, latitude of the comet	Let it be subtracted from AI, the comet's longitude on December 23
		There remains H, the point of intersection of the orbit and the ecliptic

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The angle of the orbit and the ecliptic can, however, also be found by another method (as we have in fact done in certain examples), especially when the comet's latitude on one of the two days is too slight; for then the angle is found less accurately by the method described above than by the following one given here. First, let side HI be added to the difference of longitude IK, if the point of intersection precedes or follows both of the comet's longitudes; but if that point falls between the comet's two longitudes, let it be subtracted, so that HK results. Then in triangle FKH, given KF, the comet's latitude on December 20, and HK, the hypotenuse HF is found — namely the distance the comet travelled from the first day of its appearance, December 20 at 7^{h}, up to its very intersection with the ecliptic — that is, from the logarithm made up by the sum of the antilogarithms of the sides KF and HK. Next, with the hypotenuse HF and the opposite side KF thus known, you will find the required angle of the orbit and the ecliptic, FHK or LHG, from the remainder, as it were, of the logarithms of HF and KF.

Finally, I would have you note about the former calculation that if the difference of longitude does not exceed 4 or 5 degrees but is smaller, then by no means are either the angle of the orbit or the point of intersection derived correctly enough, however great the diligence with which the observation was made. Observations should therefore be chosen in which neither too acute angles nor too small sides occur; otherwise, as we have said, all the labour will be in vain. For this reason too, in certain examples we contented ourselves with the comet's proper motion, omitting both the angle of the orbit and the ecliptic and the point of intersection. On the same ground, likewise, some angles of the orbit and the ecliptic, and certain points of intersection (as will be clear from the examples that follow), which were drawn from too acute-angled triangles, seem in part to waver. But so that we may proceed the more safely in

[197]the scheme of p. 137 continues under its three heads, repeated at the top of this page, with the same square brackets. In the sixth triangle a rule stands under the line "Let it be subtracted…", and "There remains" and "H, the point of intersection…" stand below it.

this difficult business, and so that our computations may at the same time earn the greater trust, we have hunted for that angle and that point of intersection not once or twice, as others have mostly done, but thirty times and more, as is plain from the following calculation.

[Margin: Non promiſcuè ex omnibus obſerv. angulus orbitæ omninò accuratè inveſtigatur.] (The angle of the orbit is not found quite accurately from all observations indiscriminately.)

Calculation of the daily motion, of the angle of the comet's orbit and the ecliptic, and also of the point of intersection with the Sun's path

On December 20, at 7^h in the evening. — On December 23, at 10^h 57^m 20^s

Line	Value	Points	Line	Value	Points
Latitude of the comet	30° 49′ 1″ *A.*	KF	Latitude of the comet	1° 43′ 23″	GI, *A.*
Its complement	59° 10′ 59″	EF	Its complement	88° 16′ 37″	EG

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on the 20th				68° 24′ 24″	
Longitude of the comet on the 23rd				59° 1′ 41″	
Difference of longitude	IEK			9° 22′ 43″	or IK
Log. of the complement of the latitude	EF	15221			
Log. of the angle	IEK	181429	*A.*		
Log. of the perpendicular	FN	196650		8° 2′ 40″	
Antil. of the complement of the latitude	EF	66884			
Antil. of the perpendicular	FN	989	*S.*		
Antil.	EN	65895		58° 50′ 33″	
Complement of the latitude	EG			88° 16′ 37″	
Antil. *lat.*	NG	13821		29° 26′ 4″	
Antil. of the perpendicular	FN	989	*A.*		
Antil.	FG	14810		30° 25′ 10″	proper motion
Log. of the perpendicular	FN	196650			
Log.	FG	68058	*S.*		
Log. of the angle	FGN	128592		16° 2′ 43″	or HGI

Line	Points	Logarithm	Mark	Value	Note
Antil.	GI	45			
Log.	HGI	128592	*A.*		
Antil.	GHI	128637		73° 57′ 43″	orbit and ecliptic
Log.	GI	350430	+		
Mesol.	GHI	124620	+ *A.*		
Mesol.	HI	475050	+	29′ 44″ *S.*	
Longitude of the comet on the 23rd	AI			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 31′ 57″	

Another way of finding the angle of the orbit and the ecliptic, GHI or LHG

Line	Points	Loga-rithm	Mark	Value	Note
Difference of longitude	IK			9° 22′ 43″	
Side	HI			29′ 44″ *A.*	
Side	HK			9° 52′ 27″	
Antil. of the latitude of the comet	KF	15221			
Antilog.	HK	1492	*A.*		
Antil. of the hypotenuse	HF	16713		32° 12′ 40″	
Log. of the latitude of the comet	KF	66885			
Log. of the hypotenuse	HF	62915	*S.*		
Log. of the angle	FHK	3970		73° 57′ 45″	orbit and ecliptic

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This was the method of demonstrating and computing the proper motion, etc., when, that is, both latitudes of the phenomenon are southern. Now, however, since in the following calculation the latitudes given are of different kinds — southern, namely, on the 20th, but northern on the 26th — a different figure is needed to demonstrate the calculation; for entirely different triangles arise to be solved, though exactly the same method of calculating by logarithms is kept. Let us therefore in turn set out briefly only the manner of the demonstration and of the solution (especially since the naming of the circles in the accompanying figure is wholly the same as above, except that M is the comet's place at the earlier observation and G at the later): first, what triangles are to be solved; second, from which data; and third, what is to be sought.

Diagram. An engraved figure set beside the text, drawn as that of p. 137 but for latitudes of different names: a circle, the solstitial colure, labelled "Colurus" inside it at the upper left and "Solstitiorum." along its right side. On the circle stand E at the top right, C to the right of it, B at the left, D at the lower left and A at the lower right. A straight line from B to A is labelled "Ecliptica." (ecliptic); on it stand L, H and I, in that order from B. A straight line from D to C is labelled "Orbita" (orbit) near D and "Cometæ." (of the comet) near C; on it stand M near D and G above the ecliptic, and it crosses the ecliptic at H. From E two curves descend: one labelled "Circul. Latit." (circle of latitude) through O and L to M; the other labelled "Circ. Latit." (circle of latitude) through G to I. A dotted line joins O to G. At the lower right, inside the frame, is the engraver's signature "Autor Sculps." (the author engraved it). No K, N or F is drawn.

[198] the two calculations stand side by side under the heading, the first at the left, the second (with the caption "Another way…" set within it) at the right, laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted. The marks after the figures of the right calculation's two logarithms and two mesologarithms are crosses. For the sides HI the page prints the minutes and seconds only, with no degree figure.

- E (top right, on the circle): point
- C (on the circle, right of E): point
- B (left, on the circle; end of the ecliptic): point
- D (lower left, on the circle; end of the orbit line): point
- A (lower right, on the circle; end of the ecliptic): point
- L, H, I (on the ecliptic, in order from B): points
- M (on the orbit line near D, end of the curve through O and L): point
- G (on the orbit line and the curve to I): point
- O (on the curve from E to M, joined to G by a dotted line): point
- *Colurus* and *Solstitiorum.* (inside the circle, upper left and right side): solstitial colure
- *Ecliptica.* (below the ecliptic line, right): ecliptic
- *Orbita* and *Cometæ.* (along the line D–C, lower and upper): orbit of the comet
- *Circul. Latit.* (along the curve E–O–L–M): circle of latitude
- *Circ. Latit.* (along the curve E–G–I): circle of latitude
- *Autor Sculps.* (lower right): the author engraved it

Right triangles to be solved	Given	Sought
1 Triangle GEO	Angle GEO, difference of longitude	GO, perpendicular
	Side EG, complement of the latitude of the comet	
2 Triangle GEO	Side EG, complement of the latitude of the comet	Side EO
	Side GO, perpendicular	EM, the comet's distance from the pole, is to be added
		Side OM
3 Triangle GOM	Side OM	Hypotenuse GM, namely the comet's proper motion
	Side GO, perpendicular	
4 Triangle GOM	Side GO, perpendicular	Angle HML
	Hypotenuse GM, proper motion	
5 Triangle HML	Latitude of the comet LM	Angle LHM of the comet's orbit and the ecliptic
	Angle HML, just found	
6 Triangle HML	Latitude of the comet LM	Side HL
	Angle HML	AL, longitude of the comet on the 20th; subtract
		H; there remains the point of intersection H

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2.

[199] an unruled scheme set as that of pp. 137–138, with square brackets enclosing the two data lines of each triangle. In the second triangle EO stands over EM with a rule beneath, and OM below the rule; in the sixth, AL stands under HL and H under AL, with no rule.

On December 20, at 7^h in the evening. — On December 26, at 11^h 38^m 22^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	13° 41′ 27″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	76° 18′ 33″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on the 20th				68° 24′ 24″	
Longitude of the comet on the 26th				54° 33′ 53″	
Difference IL, or angle IEL				13° 50′ 31″	
Log. of the complement of the latitude	EG	2882			
Log. of the angle	IEL	143026	*A*		
Log. of the perpendicular	GO	145908		13° 26′ 29″	
Antil. of the complement of the latitude	EG	144104			
Antil. of the perpendicular	GO	2778	*S.*		
Antil.	EO	141326		75° 54′ 57″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. *lat.*	OM	34485		44° 54′ 4″	
Antil. of the perpendicular	GO	2778	*A.*		
Antil.	GM	37263		46° 27′ 20″	proper motion
Log. of the perpendicular	GO	145908			
Logarith.	GM	32180	*S.*		
Log. of the angle	HML	113728		18° 42′ 18″	
Antil.	LM	15221	*A.*		
Antil.	LHM	128949		74° 0′ 50″	orbit and ecliptic
Log.	LM	66886	+		
Mesolog.	HML	108300	+ *A.*		
Mesolog.	HL	175186	+	9° 50′ 24″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 34′ 0″	

4.

On December 20, at 7^h in the evening. — On December 28, at 1^h 34^m 10^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	17° 10′ 50″	GI
Distance of the comet from the pole	120° 49′ 1″	EM	Complement of the latitude	72° 49′ 10″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on the 20th				68° 24′ 24″	

Line	Points	Loga-rithm	Mark	Value	Note
Longitude of the comet on the 28th				53° 24′ 50″	
Difference IL, or angle IEL				14° 59′ 34″	
Log. of the complement of the latitude	EG	4565			
Log. of the angle	IEL	135211	*A*		
Log. of the perpendicular	GO	139776		14° 18′ 32″	
Antil. of the complement of the latitude	EG	121948			
Antil. of the perpendicular	GO	3151	*S.*		
Antil.	EO	118797		72° 14′ 0″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. *lat.*	OM	41321		48° 35′ 1″	
Antil. of the perpendicular	GO	3151	*A.*		
Antil.	GM	44472		50° 8′ 0″	proper motion
Log. of the perpendicular	GO	139776			
Log.	GM	26457	*S.*		
Log. of the angle	HML	113319		18° 47′ 3″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	128534		73° 56′ 43″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	107846	+ *A.*		
Mesolog.	HL	174732	+	9° 53′ 2″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 31′ 22″	

3.

On December 20, at 7^{h} in the evening. — On December 27, at 11^{h} 44^{m} 31^{s} *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	17° 5′ 57″	GI
Distance of the comet from the pole	120° 49′ 1″	EM	Complement of the latitude	72° 54′ 3″	GE

Line	Points	Loga-rithm	Mark	Value	Note
Longitude of the comet on the 20th				68° 24′ 24″	
Longitude of the comet on the 27th				53° 23′ 24″	
Difference IL, or angle IEL				15° 1′ 0″	
Log. of the complement of the latitude	EG	4521			
Log. of the angle	IEL	135054	*A.*		
Log. of the perpendicular	GO	139575		14° 20′ 18″	
Antil. of the complement of the latitude	EG	122404			
Antil. of the perpendicular	GO	3164	*S.*		
Antil.	EO	119240		72° 19′ 59″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. *lat.*	OM	41123		48° 29′ 2″	

Line	Points	Logarithm	Mark	Value	Note
Antil. of the perpendicular	GO	3164	*A.*		
Antil.	GM	44287		50° 2′ 40″	proper motion
Log. of the perpendicular	GO	139575			
Logarith.	GM	26587	*S.*		
Log. of the angle	HML	112988		18° 50′ 56″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	128209		73° 53′ 30″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	107475	+ *A.*		
Mesolog.	HL	174361	+	9° 55′ 11″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 29′ 13″	

5.

On December 20, at 7^{h} in the evening. — On December 29, at 4^{h} 28^{m} 50^{s} *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	19° 23′ 14″	GI
Distance of the comet from the pole	120° 49′ 1″	EM	Complement of the latitude	70° 36′ 46″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on the 20th				68° 24′ 24″	
Longitude of the comet on the 29th				52° 56′ 37″	
Difference IL, or angle IEL				15° 27′ 47″	
Log. of the complement of the latitude	EG	5837			
Log. of the angle	IEL	132192	*A*		
Log. of the perpendicular	GO	138029		14° 24′ 0″	
Antil. of the complement of the latitude	EG	110277			
Antil. of the perpendicular	GO	3267	*S.*		
Antil.	EO	107010		69° 56′ 31″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. *lat.*	OM	46043		50° 52′ 30″	
Antil. of the perpendicular	GO	3267	*A.*		
Antil.	GM	49310		52° 21′ 28″	proper motion
Log. of the perpendicular	GO	138029			
Log.	GM	23339	*S.*		
Log. of the angle	HML	114690		18° 31′ 0″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	129911		74° 10′ 14″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	109373	+ *A.*		
Mesolog.	HL	176259	+	9° 44′ 14″ *S.*	

Line	Points	Loga-rithm	Mark	Value	Note
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 40′ 10″	

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6.

On December 20, at 7^h in the evening. — On January 30, at 6^h 10^m 30^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	23° 23′ 17″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	66° 36′ 43″	GE

Line	Points	Loga-rithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on December 30	AI			51° 27′ 48″	
Difference IL, or angle IEL				16° 56′ 36″	
Log. of the complement of the latitude	EG	8573			
Log. of the angle	IEL	123296	*A.*		
Log. of the perpendicular	GO	131869		15° 30′ 51″	
Antil. of the complement of the latitude	EG	92392			
Antil. of the perpendicular	GO	3712	*S.*		
Antil.	EO	88680		65° 40′ 16″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. of the side	OM	55951		55° 8′ 45″	
Antil. of the perpendicular	GO	3712	*A.*		
Antil.	GM	59663		56° 35′ 16″	proper motion
Log. of the perpendicular	GO	131869			
Logarith.	GM	18065	*S.*		
Log. of the angle	HML	113804		18° 41′ 24″	
Antil.	LM	15221	*A.*		
Antil.	LHM	129025		74° 1′ 34″	orbit and ecliptic
Log.	LM	66886	+		
Mesolog.	HML	108386	+ *A.*		
Mesolog.	HL	175272	+	9° 49′ 54″ *S.*	
Longitude of the comet on December 20	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 34′ 30″	

8.

[200] the four calculations stand in two rows of two, 2 and 4 above, 3 and 5 below, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. The page carries no prose.

On December 20, at 7^h in the evening. — On January 1, in the year 1653, at 3^h 26^m 0^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	25° 49′ 51″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	64° 10′ 9″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 1	AI			50° 44′ 45″	
Difference IL, or angle IEL				17° 39′ 39″	
Log. of the complement of the latitude	EG	10527			
Log. of the angle	IEL	119278	*A.*		
Log. of the perpendicular	GO	129805		15° 50′ 48″	
Antil. of the complement of the latitude	EG	83076			
Antil. of the perpendicular	GO	3874	*S.*		
Antil.	EO	79202		63° 4′ 5″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. of the side	OM	62807		57° 44′ 56″	
Antil. of the perpendicular	GO	3874	*A.*		
Antil.	GM	66681		59° 6′ 49″	proper motion
Log. of the perpendicular	GO	129805			
Log.	GM	15293	*S.*		
Log. of the angle	HML	114512		18° 33′ 12″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	129733		74° 8′ 30″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	109175	+ *A.*		
Mesolog.	HL	176061	+	9° 45′ 22″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 39′ 2″	

7.

On December 20, at 7^h in the evening. — On December 31, at 3^h 44^m 24^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	23° 48′ 51″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	66° 11′ 9″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on December 31	AI			51° 18′ 48″	

Line	Points	Logarithm	Mark	Value	Note
Difference IL, or angle IEL				17° 5′ 36″	
Log. of the complement of the latitude	EG	8898			
Log. of the angle	IEL	122440	*A.*		
Log. of the perpendicular	GO	131338		15° 35′ 59″	
Antil. of the complement of the latitude	EG	90691			
Antil. of the perpendicular	GO	3753	*S.*		
Antil.	EO	86938		65° 12′ 57″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. of the side	OM	57101		55° 36′ 4″	
Antil. of the perpendicular	GO	3753	*A.*		
Antil.	GM	60854		57° 2′ 1″	proper motion
Log. of the perpendicular	GO	131338			
Logarith.	GM	17556	*S.*		
Log. of the angle	HML	113782		18° 41′ 40″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	129003		74° 1′ 21″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	108360	+ *A.*		
Mesolog.	HL	175246	+	9° 50′ 4″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 34′ 20″	

9.

On December 20, at 7^h in the evening. — On January 2, at 6^h 27^m 30^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	27° 9′ 0″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	62° 51′ 0″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 2	AI			50° 28′ 0″	
Difference IL, or angle IEL				17° 56′ 24″	
Log. of the complement of the latitude	EG	11674			
Log. of the angle	IEL	117759	*A.*		
Log. of the perpendicular	GO	129433		15° 54′ 27″	
Antil. of the complement of the latitude	EG	78456			
Antil. of the perpendicular	GO	3905	*S.*		
Antil.	EO	74551		61° 40′ 26″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. of the side	OM	66768		59° 8′ 35″	
Antil. of the perpendicular	GO	3905	*A.*		
Antil.	GM	70673		60° 26′ 41″	proper motion

Line	Points	Logarithm	Mark	Value	Note
Log. of the perpendicular	GO	129433			
Log.	GM	13939	*S.*		
Log. of the angle	HML	115494		18° 21′ 54″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	130715		74° 18′ 3″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	110270	+ *A.*		
Mesolog.	HL	177156	+	9° 39′ 7″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 45′ 17″	

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10.

On December 20, at 7^h in the evening. — On January 4, at 2^h 39^m 10^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	30° 14′ 15″	GI
Distance from the pole	120° 49′ 1″	EM	Complement	59° 45′ 45″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 4	AI			49° 12′ 17″	
Difference IL, or angle IEL				19° 12′ 7″	
Log. of the complement of the latitude	EG	14624			
Log. of the angle	IEL	111200	*A.*		
Log. of the perpendicular	GO	125824		16° 30′ 31″	
Antil. of the complement of the latitude	EG	68599			
Antil. of the perpendicular	GO	4210	*S.*		
Antil.	EO	64389		58° 18′ 54″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. of the side	OM	77279		62° 30′ 7″	
Antil. of the perpendicular	GO	4210	*A.*		
Antilog.	GM	81489		63° 43′ 28″	proper motion
Log. of the perpendicular	GO	125824			
Log.	GM	10907	*S.*		
Log. of the angle	HML	114917		18° 28′ 31″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	130138		74° 12′ 27″	orbit and ecliptic

[201] the four calculations stand in two rows of two, 6 and 8 above, 7 and 9 below, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. The page carries no prose.

Line	Points	Logarithm	Mark	Value	Note
Log.	LM	66886	+		
Mesolog.	HML	109627	+ *A.*		
Mesolog.	HL	176513	+	9° 42′ 47″	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 41′ 37″	

12.
On December 20, at 7^h in the evening. — On January 7, at 2^h 41^m 0^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30 49′ 1″	LM	Latitude of the comet, *B.*	31° 55′ 36″	GI
Distance from the pole	120° 49′ 1″	EM	Complement	58° 4′ 24″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 7	AI			49° 27′ 23″	
Difference IL, or angle IEL				18° 57′ 1″	
Log. of the complement of the latitude	EG	16402			
Log. of the angle	IEL	112472	*A.*		
Log. of the perpendicular	GO	128874		15° 59′ 55″	
Antil. of the complement of the latitude	EG	63708			
Antil. of the perpendicular	GO	3950	*S.*		
Antil.	EO	59758		56° 37′ 26″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. of the side	OM	83163		64° 11′ 35″	
Antil. of the perpendicular	GO	3950	*A.*		
Antil.	GM	87113		65° 15′ 39″	proper motion
Log. of the perpendicular	GO	128874			
Log.	GM	9627	*S.*		
Log. of the angle	HML	119247		17° 39′ 59″	
Antilog.	LM	15221	*A.*		
Antilog.	LHM	134468		74° 53′ 34″	orbit and ecliptic
Log.	LM	66886	+		
Mesolog.	HML	114415	+ *A.*		
Mesolog.	HL	181301	+	9° 16′ 1″	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			59° 8′ 23″	

11.
On December 20, at 7^h in the evening. — On January 4, at 2^h 53^m 30^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B*	29° 5′ 1″	GI
Distance from the pole	120° 49′ 1″	EM	Complement	60° 54′ 59″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 4	AI			50° 30′ 12″	
Difference IL, or angle IEL				17° 54′ 12″	
Log. of the complement of the latitude	EG	13477			
Log. of the angle	IEL	117957	*A.*		
Log. of the perpendicular	GO	131434		15° 34′ 2″	
Antil. of the complement of the latitude	EG	72138			
Antil. of the perpendicular	GO	3745	*S.*		
Antilog.	EO	68393		59° 41′ 38″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. of the side	OM	72789		61° 7′ 23″	
Antil. of the perpendicular	GO	3745	*A.*		
Antil.	GM	76534		62° 16′ 43″	proper motion
Log. of the perpendicular	GO	131434			
Log.	GM	12190	*S.*		
Log. of the angle	HML	119244		17° 40′ 0″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	134465		74° 53′ 33″	orbit and ecliptic
Log.	LM	66886	+		
Mesolog.	HML	114413	+ *A.*		
Mesolog.	HL	181299	+	9° 16′ 1″	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			59° 8′ 23″	

13.

On December 20, at 7^h in the evening. — On December 26, at 9^h 0^m 34^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	13° 24′ 18″	GI
Distance from the pole	120° 49′ 1″	EM	Complement	76° 35′ 42″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on December 26	AI			54° 35′ 30″	
Difference IL, or angle IEL				13° 48′ 54″	
Log. of the complement of the latitude	EG	2762			
Log. of the angle	IEL	143216	*A.*		

Line	Points	Logarithm	Mark	Value	Note
Log. of the perpendicular	GO	145978		13° 25′ 55″	
Antil. of the complement of the latitude	EG	146172			
Antil. of the perpendicular	GO	2773	*S.*		
Antil.	EO	143399		76° 12′ 38″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. of the side	OM	33975		44° 36′ 23″	
Antil. of the perpendicular	GO	2773	*A.*		
Antil.	GM	36748		46° 10′ 24″	proper motion
Log. of the perpendicular	GO	145978			
Log.	GM	32650	*S.*		
Log. of the angle	HML	113328		18° 46′ 57″	
Antilog.	LM	15221	*A.*		
Antil. of the angle	LHM	128549		73° 56′ 52″	orbit and ecliptic
Log.	LM	66886	+		
Mesolog.	HML	107855	+ *A.*		
Mesolog.	HL	174741	+	9° 52′ 59″	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 31′ 25″	

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14.
On December 20, at 7^h *v.* — On December 29, at 4^h 5^m 50^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	19° 55′ 21″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	70° 4′ 39″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on December 29	AI			52° 32′ 39″	
Difference IL, or angle IEL				15° 51′ 45″	
Log. of the complement of the latitude	EG	6171			
Log. of the angle	IEL	129708	*A.*		
Log. of the perpendicular	GO	135879		14° 53′ 26″	
Antil. of the complement of the latitude	EG	107659			
Antil. of the perpendicular	GO	3415	*S.*		
Antil.	EO	104244		69° 21′ 15″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. of the side	OM	47261		51° 27′ 46″	

[202] the four calculations stand in two rows of two, 10 and 12 above, 11 and 13 below, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. On this page no *S.* follows the figures of the side HL. The page carries no prose.

Line	Points	Logarithm	Mark	Value	Note
Antil. of the perpendicular	GO	3415	*A.*		
Antil.	GM	50676		52° 57′ 19″	proper motion
Log. of the perpendicular	GO	135879			
Logarith.	GM	22543	*S.*		
Log. of the angle	HML	113336		18° 46′ 52″	
Antil.	LM	15221	*A.*		
Antil.	LHM	128557		73° 56′ 56″	orbit and ecliptic
Log.	LM	66886	+		
Mesolog.	HML	107863	+ *A.*		
Mesolog.	HL	174749	+	9° 52′ 56″ *S.*	
Longitude of the comet on December 20	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 31′ 28″	

16.

On December 20, at 7^h in the evening. — On January 1, 1653, at 2^h 52^m 49^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	25° 44′ 43″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	64° 15′ 17″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 1	AI			50° 55′ 29″	
Difference IL, or angle IEL				17° 28′ 55″	
Log. of the complement of the latitude	EG	10455			
Log. of the angle	IEL	120265	*A.*		
Log. of the perpendicular	GO	130720		15° 41′ 56″	
Antil. of the complement of the latitude	EG	83385			
Antil. of the perpendicular	GO	3801	*S.*		
Antil.	EO	79584		63° 10′ 43″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. of the side	OM	62500		57° 38′ 18″	
Antil. of the perpendicular	GO	3801	*A.*		
Antil.	GM	66301		58° 58′ 57″	proper motion
Log. of the perpendicular	GO	130720			
Log.	GM	15430	*S.*		
Log. of the angle	HML	115290		18° 24′ 15″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	130511		74° 16′ 4″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	110041	+ *A.*		
Mesolog.	HL	176927	+	9° 40′ 25″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	

Line	Points	Logarithm	Mark	Value	Note
Point of intersection with the ecliptic	H			58° 43′ 59″	

15.
On December 20, at 7^h *v.* — On December 31, at 4^h 7^m 18^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	24° 3′ 3″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	65° 56′ 57″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on December 31	AI			51° 28′ 40″	
Difference IL, or angle IEL				16° 55′ 44″	
Log. of the complement of the latitude	EG	9083			
Log. of the angle	IEL	123380	*A.*		
Log. of the perpendicular	GO	132463		15° 25′ 14″	
Antil. of the complement of the latitude	EG	89761			
Antil. of the perpendicular	GO	3666	*S.*		
Antil.	EO	86095		64° 59′ 29″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. of the side	OM	57675		55° 49′ 32″	
Antil. of the perpendicular	GO	3666	*A.*		
Antil.	GM	61341		57° 12′ 48″	proper motion
Log. of the perpendicular	GO	132463			
Logarith.	GM	17354	*S.*		
Log. of the angle	HML	115109		18° 26′ 19″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	130330		74° 14′ 19″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	109841	+ *A.*		
Mesolog.	HL	176727	+	9° 41′ 33″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 42′ 51″	

17.
On December 20, at 7^h *v.* — On January 3, at 6^h 47^m 30^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B*	29° 2′ 40″	GI
Distance from the pole	120° 49′ 1″	EM	Complement of the latitude	60° 57′ 20″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 3	AI			50° 10′ 41″	
Difference IL, or angle IEL				18° 13′ 43″	
Log. of the complement of the latitude	EG	13439			
Log. of the angle	IEL	116215	*A.*		
Log. of the perpendicular	GO	129654		15° 52′ 16″	
Antil. of the complement of the latitude	EG	72261			
Antil. of the perpendicular	GO	3886	*S.*		
Antil.	EO	68375		59° 41′ 15″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. of the side	OM	72809		61° 7′ 46″	
Antil. of the perpendicular	GO	3886	*A.*		
Antil.	GM	76695		62° 19′ 38″	proper motion
Log. of the perpendicular	GO	129654			
Log.	GM	12146	*S.*		
Log. of the angle	HML	117508		17° 59′ 11″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	132729		74° 37′ 17″	orbit and ecliptic
Logarith.	LM	66886	+		
Mesolog.	HML	112498	+ *A.*		
Mesolog.	HL	179384	+	9° 26′ 35″ *S.*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 57′ 49″	

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18.
On December 20, at 7^h in the evening. — On January 4, at $2^h\ 3^m\ 24^s$ *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	29° 30′ 46″	GI
Distance from the pole	120° 49′ 1″	EM	Complement	60° 29′ 14″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 4	AI			49° 42′ 7″	
Difference IL, or angle IEL				18° 42′ 7″	
Log. of the complement of the latitude	EG	13898			
Log. of the angle	IEL	113742	*A.*		
Log. of the perpendicular	GO	127640		16° 12′ 10″	

[203] the four calculations stand in two rows of two, 14 and 16 above, 15 and 17 below, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. The page carries no prose.

Line	Points	Logarithm	Mark	Value	Note
Antil. of the complement of the latitude	EG	70803			
Antil. of the perpendicular	GO	4053	*S.*		
Antil.	EO	66750		59° 8′ 13″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antilog. of the side	OM	74571		61° 40′ 0″	
Antil. of the perpendicular	GO	4053	*A.*		
Antilog.	GM	78624		62° 53′ 58″	proper motion
Log. of the perpendicular	GO	127640			
Log.	GM	11632	*S.*		
Log. of the angle	HML	116008		18° 16′ 0″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	131229		74° 22′ 59″	orbit and ecliptic
Log.	LM	66886	+		
Mesolog.	HML	110836	+ *A.*		
Mesolog.	HL	177722	+	9° 35′ 53″ *S*	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			58° 48′ 31″	

20.

On December 23, at 10^{h} 57^{m} 20^{s} *v.* — On December 26, at 11^{h} 38^{m} 22^{s} *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	13° 41′ 27″	GI
Distance from the pole	91° 43′ 23″	EM	Complement	76° 18′ 33″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on December 26	AI			54° 33′ 53″	
Difference IL, or angle IEL				4° 27′ 48″	
Log. of the complement of the latitude	EG	2882			
Log. of the angle	IEL	255331	*A.*		
Log. of the perpendicular	GO	258213		4° 20′ 11″	
Antil. of the complement of the latitude	EG	144104			
Antil. of the perpendicular	GO	286	*S.*		
Antil.	EO	143818		76° 16′ 10″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	3683		15° 27′ 13″	
Antil. of the perpendicular	GO	286	*A.*		
Antil.	GM	3969		16° 2′ 8″	proper motion
Log. of the perpendicular	GO	258213			
Log.	GM	128652	*S.*		
Log. of the angle	HML	129561		15° 53′ 11″	
Antilog.	LM	45	*A.*		

Line	Points	Logarithm	Mark	Value	Note
Antilog.	LHM	129606		74° 7′ 15″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	125667	+ *A.*		
Mesolog.	HL	476097	+	0° 29′ 25″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 32′ 16″	

19.
On December 20, at 7^h *v.* — On January 7, at 2^h 26^m 9^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	30° 49′ 1″	LM	Latitude of the comet, *B.*	31° 50′ 26″	GI
Distance from the pole	120° 49′ 1″	EM	Complement	58° 9′ 34″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 20	AL			68° 24′ 24″	
Longitude of the comet on January 7	AI			49° 41′ 56″	
Difference IL, or angle IEL				18° 42′ 28″	
Log. of the complement of the latitude	EG	16309			
Log. of the angle	IEL	113713	*A.*		
Log. of the perpendicular	GO	130022		15° 48′ 29″	
Antil. of the complement of the latitude	EG	63950			
Antil. of the perpendicular	GO	3878	*S.*		
Antilog.	EO	60072		56° 44′ 31″	
Distance of the comet from the pole	EM			120° 49′ 1″	
Antil. of the side	OM	82738		64° 4′ 30″	
Antil. of the perpendicular	GO	3878	*A.*		
Antil.	GM	86616		65° 7′ 50″	proper motion
Log. of the perpendicular	GO	130022			
Log.	GM	9753	*S.*		
Log. of the angle	HML	120269		17° 28′ 52″	
Antil.	LM	15221	*A.*		
Antil. of the angle	LHM	135490		75° 3′ 0″	orbit and ecliptic
Log.	LM	66886	+		
Mesolog.	HML	115538	+ *A.*		
Mesolog.	HL	182424	+	9° 17′ 5″	
Longitude of the comet on the 20th	AL			68° 24′ 24″	
Point of intersection with the ecliptic	H			59° 7′ 19″	

21.
On December 23, at 10^h 57^m 20^s in the evening. — On December 27, at 11^h 44^m 31^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	17° 5′ 57″	GI
Distance from the pole	91° 43′ 23″	EM	Complement	72° 54′ 3″	GE

Line	Points	Loga-rithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on December 27	AI			53° 23′ 24″	
Difference IL, or angle IEL				5° 38′ 17″	
Log. of the complement of the latitude	EG	4521			
Log. of the angle	IEL	232031	*A.*		
Log. of the perpendicular	GO	236552		5° 23′ 17″	
Antil. of the complement of the latitude	EG	122404			
Antil. of the perpendicular	GO	443	*S.*		
Antil.	EO	121961		72° 49′ 18″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antil. of the side	OM	5543		18° 54′ 5″	
Antil. of the perpendicular	GO	443	*A.*		
Antil.	GM	5986		19° 37′ 38″	proper motion
Log. of the perpendicular	GO	236552			
Log.	GM	109093	*S.*		
Log. of the angle	HML	127459		16° 13′ 59″	
Antilog.	LM	45	*A.*		
Antil. of the angle	LHM	127504		73° 46′ 28″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	123391	+ *A.*		
Mesolog.	HL	473826	+	0° 30′ 6″	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 31′ 35″	

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22.
On December 23, at 10^h 57^m 20^s *v.* — On December 28, at 1^h 34^m 10^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	17° 10′ 50″	GI
Distance from the pole	91° 43′ 23″	EM	Complement of the latitude	72° 49′ 10″	GE

[204] the four calculations stand in two rows of two, 18 and 20 above, 19 and 21 below, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. Calculations 20 and 21 take December 23, with the comet's southern latitude of 1° 43′ 23″, as the earlier day. The page carries no prose.

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on December 28	AI			53° 24′ 50″	
Difference IL, or angle IEL				5° 36′ 51″	
Log. of the complement of the latitude	EG	4565			
Log. of the angle	IEL	232450	*A.*		
Log. of the perpendicular	GO	237015		5° 21′ 47″	
Antil. of the complement of the latitude	EG	121948			
Antil. of the perpendicular	GO	438	*S.*		
Antil.	EO	121510		72° 44′ 29″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antil. of the side	OM	5591		18° 58′ 54″	
Antil. of the perpendicular	GO	438	*A.*		
Antil.	GM	6029		19° 41′ 18″	proper motion
Log. of the perpendicular	GO	237015			
Logarithm	GM	108753	*S.*		
Log. of the angle	HML	128262		16° 5′ 58″	
Antil.	LM	45	*A.*		
Antil.	LHM	128307		73° 54′ 28″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	124264	+ *A.*		
Mesolog.	HL	474694	+	29′ 50″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 31′ 51″	

24.

On December 23, at 10^h 57^m 20^s in the evening. — On December 30, at 6^h 10^m 30^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	23° 23′ 17″	GI
Distance from the pole	91° 43′ 23″	EM	Complement of the latitude	66° 36′ 43″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on December 30	AI			51° 27′ 48″	
Difference IL, or angle IEL				7° 33′ 52″	
Log. of the complement of the latitude	EG	8573			
Log. of the angle	IEL	202761	*A.*		
Log. of the perpendicular	GO	211334		6° 56′ 25″	
Antil. of the complement of the latitude	EG	92392			
Antil. of the perpendicular	GO	735	*S.*		
Antil.	EO	91657		66° 25′ 45″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antil. of the side	OM	10078		25° 17′ 38″	

Line	Points	Logarithm	Mark	Value	Note
Antil. of the perpendicular	GO	735	*A.*		
Antil.	GM	10813		26° 10′ 5″	proper motion
Log. of the perpendicular	GO	211334			
Log.	GM	81870	*S.*		
Log. of the angle	HML	129464		15° 54′ 8″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	129509		74° 6′ 18″	orbit and ecliptic
Logarithm	LM	350430	+		
Mesolog.	HML	125563	+ *A.*		
Mesolog.	HL	475993	+	0° 29′ 27″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 32′ 14″	

23.
On December 23, at $10^h\ 57^m\ 20^s$ *v.* — On December 29, at $4^h\ 28^m\ 50^s$ *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	19° 23′ 14″	GI
Distance from the pole	91° 43′ 23″	EM	Complement of the latitude	70° 36′ 46″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on December 29	AI			52° 56′ 37″	
Difference IL, or angle IEL				6° 5′ 4″	
Log. of the complement of the latitude	EG	5837			
Log. of the angle	IEL	224437	*A.*		
Log. of the perpendicular	GO	230274		5° 44′ 18″	
Antil. of the complement of the latitude	EG	110277			
Antil. of the perpendicular	GO	502	*S.*		
Antil.	EO	109775		70° 30′ 40″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	7015		21° 12′ 43″	
Antil. of the perpendicular	GO	502	*A.*		
Antil.	GM	7517		21° 56′ 20″	proper motion
Log. of the perpendicular	GO	230274			
Logarithm	GM	98452	*S.*		
Log. of the angle	HML	131822		15° 31′ 20″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	131867		74° 29′ 7″	orbit and ecliptic
Logarithm	LM	350430	+		
Mesolog.	HML	128106	+ *A.*		
Mesolog.	HL	478536	+	0° 28′ 42″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 32′ 59″	

25.
On December 23, at $10^h\ 57^m\ 20^s$ *v.* — On December 31, at $3^h\ 44^m\ 24^s$ *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	23° 48′ 51″	GI
Distance from the pole	91° 43′ 23″	EM	Complement of the latitude	66° 11′ 9″	GE

Line	Points	Loga-rithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on December 31	AI			51° 18′ 48″	
Difference IL, or angle IEL				7° 42′ 53″	
Log. of the complement of the latitude	EG	8898			
Log. of the angle	IEL	200811	*A.*		
Log. of the perpendicular	GO	209709		7° 3′ 16″	
Antil. of the complement of the latitude	EG	90691			
Antil. of the perpendicular	GO	760	*S.*		
Antil.	EO	89931		65° 59′ 34″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	10440		25° 43′ 51″	
Antil. of the perpendicular	GO	760	*A.*		
Antil.	GM	11200		26° 36′ 51″	proper motion
Log. of the perpendicular	GO	209709			
Log.	GM	80299	*S.*		
Log. of the angle	HML	129410		15° 54′ 40″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	129455		74° 5′ 47″	orbit and ecliptic
Logarithm	LM	350430	+		
Mesolog.	HML	125505	+ *A.*		
Mesolog.	HL	475935	+	0° 29′ 28″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 32′ 13″	

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26.
On December 23, at $10^h\ 57^m\ 20^s$ *v.* — On December 31, at $4^h\ 27^m\ 22^s$ *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	24° 16′ 40″	GI
Distance from the pole	91° 43′ 23″	EM	Complement	65° 43′ 20″	GE

[205] the four calculations stand in two rows of two, 22 and 24 above, 23 and 25 below, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. All four take December 23, with the comet's southern latitude of 1° 43′ 23″, as the earlier day. In calculation 22 the value beside the mesologarithm of HL is printed with no degree figure. The page carries no prose.

Line	Value	Points	Line	Value	Points

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on December 31	AI			51° 4′ 0″	
Difference IL, or angle IEL				7° 57′ 41″	
Log. of the complement of the latitude	EG	9260			
Log. of the angle	IEL	197683	*A.*		
Log. of the perpendicular	GO	206943		7° 15′ 12″	
Antil. of the complement of the latitude	EG	88878			
Antil. of the perpendicular	GO	804	*S.*		
Antil.	EO	88074		65° 30′ 47″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	10848		26° 12′ 36″	
Antil. of the perpendicular	GO	804	*A.*		
Antilog.	GM	11652		27° 7′ 40″	proper motion
Log. of the perpendicular	GO	206943			
Log.	GM	78529	*S.*		
Log. of the angle	HML	128414		16° 4′ 29″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	128459		73° 55′ 58″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	124426	+ *A.*		
Mesolog.	HL	474856	+	0° 29′ 47″	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 31′ 54″	

28.
On December 23, at $10^{h}\ 57^{m}\ 20^{s}$ *v.* — On January 1, at $2^{h}\ 52^{m}\ 49^{s}$ *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1 43′ 23″	LM	Latitude of the comet, *B.*	25° 44′ 43″	GI
Distance from the pole	91° 43′ 23″	EM	Complement	64° 15′ 17″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 1	AI			50° 55′ 29″	
Difference IL, or angle IEL				8° 6′ 12″	
Log. of the complement of the latitude	EG	10455			
Log. of the angle	IEL	195929	*A.*		
Log. of the perpendicular	GO	206384		7° 17′ 39″	
Antil. of the complement of the latitude	EG	83385			
Antil. of the perpendicular	GO	813	*S.*		

Line	Points	Logarithm	Mark	Value	Note
Antil.	EO	82572		64° 1′ 43″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	12169		27° 41′ 40″	
Antil. of the perpendicular	GO	813	*A.*		
Antil.	GM	12982		28° 34′ 3″	proper motion
Log. of the perpendicular	GO	206384			
Log.	GM	73774	*S.*		
Log. of the angle	HML	132610		15° 23′ 49″	
Antilog.	LM	45	*A.*		
Antilog.	LHM	132655		74° 36′ 34″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	128957	+ *A.*		
Mesolog.	HL	479387	+	0° 28′ 28″	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 33′ 13″	

27.
On December 23, at $10^h\ 57^m\ 20^s$ *v.* — On January 1, at $2^h\ 20^m\ 43^s$ *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	25° 43′ 53″	GI
Distance from the pole	91° 43′ 23″	EM	Complement	64° 16′ 7″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 1	AI			50° 59′ 47″	
Difference IL, or angle IEL				8° 1′ 54″	
Log. of the complement of the latitude	EG	10443			
Log. of the angle	IEL	196813	*A.*		
Log. of the perpendicular	GO	207256		7° 13′ 50″	
Antil. of the complement of the latitude	EG	83436			
Antil. of the perpendicular	GO	798	*S.*		
Antilog.	EO	82638		64° 2′ 50″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antil. of the side	OM	12152		27° 40′ 33″	
Antil. of the perpendicular	GO	798	*A.*		
Antil.	GM	12950		28° 32′ 3″	proper motion
Log. of the perpendicular	GO	207256			
Log.	GM	73880	*S.*		
Log. of the angle	HML	133376		15° 16′ 37″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	133421		74° 43′ 48″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	129779	+ *A.*		

Line	Points	Logarithm	Mark	Value	Note
Mesolog.	HL	480209	+	0° 28′ 14″	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 33′ 27″	

29.

On December 23, at 10^h 57^m 20^s in the evening. — On January 1, at 3^h 26^m 0^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	25° 49′ 51″	GI
Distance from the pole	91° 43′ 23″	EM	Complement	64° 10′ 9″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 1	AI			50° 44′ 45″	
Difference IL, or angle IEL				8° 16′ 56″	
Log. of the complement of the latitude	EG	10527			
Log. of the angle	IEL	193762	*A.*		
Log. of the perpendicular	GO	204289		7° 26′ 59″	
Antil. of the complement of the latitude	EG	83076			
Antil. of the perpendicular	GO	848	*S.*		
Antil.	EO	82228		63° 55′ 57″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antil. of the side	OM	12256		27° 47′ 26″	
Antil. of the perpendicular	GO	848	*A.*		
Antil.	GM	13104		28° 41′ 43″	proper motion
Log. of the perpendicular	GO	204289			
Log.	GM	73365	*S.*		
Log. of the angle	HML	130924		15° 39′ 58″	
Antilog.	LM	45	*A.*		
Antil. of the angle	LHM	130969		74° 20′ 30″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	127134	+ *A.*		
Mesolog.	HL	477564	+	0° 28′ 59″	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 32′ 52″	

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30.
On December 23, at 10^h 57^m 20^s *v.* — On January 2, at 6^h 27^m 30^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	29° 9′ 0″	GI
Distance from the pole	91° 43′ 23″	EM	Complement of the latitude	62° 51′ 0″	GE

Line	Points	Loga-rithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 2	AI			50° 28′ 0″	
Difference IL, or angle IEL				8° 33′ 41″	
Log. of the complement of the latitude	EG	11674			
Log. of the angle	IEL	190470	*A.*		
Log. of the perpendicular	GO	202144		7° 36′ 44″	
Antil. of the complement of the latitude	EG	78456			
Antil. of the perpendicular	GO	885	*S.*		
Antil.	EO	77571		62° 35′ 20″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antil. of the side	OM	13527		29° 8′ 3″	
Antil. of the perpendicular	GO	885	*A.*		
Antil.	GM	14412		30° 1′ 37″	proper motion
Log. of the perpendicular	GO	202144			
Logarithm	GM	69234	*S.*		
Log. of the angle	HML	132910		15° 21′ 0″	
Antil.	LM	45	*A.*		
Antil.	LHM	132955		74° 39′ 25″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	129278	+ *A.*		
Mesolog.	HL	479608	+	0° 28′ 24″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 33′ 17″	

32.
On December 23, at 10^h 57^m 20^s in the evening. — On January 4, at 2^h 3^m 24^s *m.*

[206] the four calculations stand in two rows of two, 26 and 28 above, 27 and 29 below, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. All four take December 23, with the comet's southern latitude of 1° 43′ 23″, as the earlier day; calculations 27, 28 and 29 all take January 1 as the later day, at three different hours. In calculation 28 the first latitude is printed with no degree mark. The page carries no prose.

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	29° 30′ 46″	GI
Distance from the pole	91° 43′ 23″	EM	Complement of the latitude	60° 29′ 14″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 4	AI			49° 42′ 7″	
Difference IL, or angle IEL				9° 19′ 34″	
Log. of the complement of the latitude	EG	13898			
Log. of the angle	IEL	181981	*A.*		
Log. of the perpendicular	GO	195879		8° 6′ 27″	
Antil. of the complement of the latitude	EG	70803			
Antil. of the perpendicular	GO	1005	*S.*		
Antil.	EO	69798		60° 9′ 36″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antil. of the side	OM	16009		31° 33′ 47″	
Antil. of the perpendicular	GO	1005	*A.*		
Antil.	GM	17014		32° 29′ 0″	proper motion
Log. of the perpendicular	GO	195879			
Log.	GM	62166	*S.*		
Log. of the angle	HML	133713		15° 13′ 27″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	133758		74° 46′ 57″	orbit and ecliptic
Logarithm	LM	350430	+		
Mesolog.	HML	130142	+ *A.*		
Mesolog.	HL	480572	+	0° 28′ 8″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 33′ 33″	

31.
On December 23, at 10^h 57^m 20^s *v.* — On January 3, at 6^h 47^m 30^s *v.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	29° 2′ 40″	GI
Distance from the pole	91° 43′ 23″	EM	Complement of the latitude	60° 57′ 20″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 3	AI			50° 10′ 41″	
Difference IL, or angle IEL				8° 51′ 0″	
Log. of the complement of the latitude	EG	13439			
Log. of the angle	IEL	187179	*A.*		
Log. of the perpendicular	GO	200618		7° 43′ 47″	

Line	Points	Logarithm	Mark	Value	Note
Antil. of the complement of the latitude	EG	72261			
Antil. of the perpendicular	GO	913	*S.*		
Antil.	EO	71348		60° 39′ 47″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	15476		31° 3′ 36″	
Antil. of the perpendicular	GO	913	*A.*		
Antil.	GM	16389		31° 54′ 53″	proper motion
Log. of the perpendicular	GO	200618			
Logarithm	GM	63741	*S.*		
Log. of the angle	HML	136877		14° 44′ 22″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	136922		75° 16′ 3″	orbit and ecliptic
Logarithm	LM	350430	+		
Mesolog.	HML	133529	+ *A.*		
Mesolog.	HL	483959	+	0° 27′ 12″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 34′ 29″	

33.
On December 23, at $10^h\ 57^m\ 20^s$ *v.* — On January 4, at $2^h\ 39^m\ 10^s$ *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	30° 14′ 15″	GI
Distance from the pole	91° 43′ 23″	EM	Complement of the latitude	59° 45′ 45″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 4	AI			49° 12′ 17″	
Difference IL, or angle IEL				9° 49′ 24″	
Log. of the complement of the latitude	EG	14624			
Log. of the angle	IEL	176837	*A.*		
Log. of the perpendicular	GO	191461		8° 28′ 34″	
Antil. of the complement of the latitude	EG	68599			
Antil. of the perpendicular	GO	1098	*S.*		
Antil.	EO	67501		59° 23′ 35″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	16843		32° 19′ 48″	
Antil. of the perpendicular	GO	1098	*A.*		
Antil.	GM	17941		33° 18′ 17″	proper motion
Log. of the perpendicular	GO	191461			
Log.	GM	59949	*S.*		
Log. of the angle	HML	131512		15° 34′ 18″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	131557		74° 26′ 8″	orbit and ecliptic

Line	Points	Logarithm	Mark	Value	Note
Logarithm	LM	350430	+		
Mesolog.	HML	127772	+ *A.*		
Mesolog.	HL	478202	+	0° 28′ 48″ *S.*	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 32′ 53″	

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34.
On December 23, at 10^h 57^m 20^s *v.* — On January 4, at 2^h 53^m 30^s *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1° 43′ 23″	LM	Latitude of the comet, *B.*	29° 5′ 1″	GI
Distance from the pole	91° 43′ 23″	EM	Complement	60° 54′ 59″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 4	AI			50° 30′ 12″	
Difference IL, or angle IEL				8° 31′ 29″	
Log. of the complement of the latitude	EG	13477			
Log. of the angle	IEL	190896	*A.*		
Log. of the perpendicular	GO	204373		7° 26′ 36″	
Antil. of the complement of the latitude	EG	72138			
Antil. of the perpendicular	GO	846	*S.*		
Antil.	EO	71292		60° 38′ 42″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	15494		31° 4′ 41″	
Antil. of the perpendicular	GO	846	*A.*		
Antilog.	GM	16340		31° 52′ 10″	proper motion
Log. of the perpendicular	GO	204373			
Log.	GM	63868	*S.*		
Log. of the angle	HML	140505		14° 12′ 10″	
Antil.	LM	45	*A.*		
Antil. of the angle	LHM	140550		75° 48′ 14″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	137401	+ *A.*		
Mesolog.	HL	487831	+	0° 26′ 10″	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 35′ 31″	

[207] the four calculations stand in two rows of two, 30 and 32 above, 31 and 33 below, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. All four take December 23, with the comet's southern latitude of 1° 43′ 23″, as the earlier day. The page carries no prose.

35.
On December 23, at $10^h\ 57^m\ 20^s$ *v.* — On January 7, at $2^h\ 26^m\ 9^s$ *m.*

Line	Value	Points	Line	Value	Points
Latitude of the comet, *A.*	1 43′ 23″	LM	Latitude of the comet, *B.*	31° 50′ 26″	GI
Distance from the pole	91° 43′ 23″	EM	Complement	58° 9′ 34″	GE

Line	Points	Logarithm	Mark	Value	Note
Longitude of the comet on December 23	AL			59° 1′ 41″	
Longitude of the comet on January 7	AI			49° 41′ 56″	
Difference IL, or angle IEL				9° 19′ 45″	
Log. of the complement of the latitude	EG	16309			
Log. of the angle	IEL	181948	*A.*		
Log. of the perpendicular	GO	198257		7° 54′ 56″	
Antil. of the complement of the latitude	EG	63950			
Antil. of the perpendicular	GO	958	*S.*		
Antil.	EO	62992		57° 48′ 59″	
Distance of the comet from the pole	EM			91° 43′ 23″	
Antilog. of the side	OM	18638		33° 54′ 24″	
Antil. of the perpendicular	GO	958	*A.*		
Antil.	GM	19596		34° 42′ 40″	proper motion
Log. of the perpendicular	GO	198257			
Log.	GM	56310	*S.*		
Log. of the angle	HML	141947		13° 59′ 42″	
Antilog.	LM	45	*A.*		
Antilog.	LHM	141992		76° 0′ 39″	orbit and ecliptic
Log.	LM	350430	+		
Mesolog.	HML	138935	+ *A.*		
Mesolog.	HL	489365	+	0° 25′ 46″	
Longitude of the comet on the 23rd	AL			59° 1′ 41″	
Point of intersection with the ecliptic	H			58° 35′ 55″	

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[Margin: Cur tàm prolixisſimo calculo angulum orbitæ & Eclipticæ autor inveſtigatum iverit?] (Why did the author set out to investigate the angle of the orbit and the ecliptic with so very long a calculation?)

Almost to the point of nausea, in the judgement of some perhaps, we have sought by the calculation above both the angle of the orbit and the ecliptic, that is, the inclination, and the place of its intersection. Yet I do not regret

[208] the two calculations stand side by side, 34 on the left and 35 on the right, each laid out as the calculations of the preceding pages, with rules under the figures that are added or subtracted; the marks after the logarithm of LM and the two mesologarithms are crosses. Both take December 23, with the comet's southern latitude of 1° 43′ 23″, as the earlier day. In calculation 35 the first latitude is printed with no degree mark. Prose follows below them.

this labour, however extremely tedious, nor will you regret it, my Astrophile [Aſtrophile: lover of the stars, the reader]. For from the accurate investigation of this angle it is beyond all doubt that the said angle of the orbit and the ecliptic was not of the same size throughout the whole time of the apparition, as all the other observers whose writings I have chanced to see and read supposed. Rather, it changed continually from the comet's first rising right to its extinction, just as that point of intersection also did not always stay at the same place of the ecliptic: the comet's orbit cut the ecliptic gradually at one place after another.

[Margin: An angulus orbitæ Cometarum varietur?] (Whether the angle of the orbit of comets varies?)

So from this there arises a question of the greatest moment, one not yet brought into the open so far, let alone decided: namely, whether the angle of inclination, both of this comet and of all the others, was always unequal, or sometimes equal; and if it was subject to variation [recte: variationi], whether it increased continuously, or also sometimes decreased, and in what proportion this came about.

[Margin: An ex variatione anguli hujus, Cometæ neceſſariò in minori aliquo moveantur circulo?] (Whether, from the variation of this angle, comets necessarily move in some smaller circle?)

Further, if the angle of the orbit of comets and the ecliptic, or the equator, varies in this way from day to day, as will indeed become clear from what is to be said, it is rightly asked whether these phenomena move in a great circle, or in some smaller one; and whether it must be concluded infallibly from this that comets have notable parallaxes, and so move in the aerial region.

I admit, indeed, that at first sight it may seem to some, especially to anyone devoted to the Peripatetic school, that we have supplied an excellent and infallible argument for establishing the Peripatetics' opinion about comets. But I beg you to suspend your judgement until this matter is treated more fully. That can conveniently be done when the place of comets is discussed expressly in Book V, to which I also put off the questions just raised.

Now, however, let us return to our comet and inquire carefully how great and of what kind its proper motion was, both the daily motion for each single day and the hourly; likewise how large the angle of inclination to the ecliptic was, and how it varied from day to day, together with the place of intersection with the ecliptic, or node. So that this business may succeed the better, let us bring into a table both the proper motion and the said angle, together with the node, as found from the preceding calculation. In this way it will easily become clear what happened in this matter, and what we ought to conclude.

But I think I should first give notice here that both the proper motion and the angle of inclination, etc., were investigated not from observations of one kind only, namely from the comet's altitudes and azimuths, but equally also from those that rest on distances, and equally also from altitudes and distances taken together, for the sake of greater certainty. For in this way I was made the more certain of everything; and I noticed at last that while the proper motion

could be determined accurately from every calculation, the angle of the orbit, together with the node, could be determined best of all only from the distances; although, if you attend carefully, the results from the remaining observations scarcely differ even by one or two minutes. Therefore we have also given the first place in the following little table to these, namely to the results from the distances, even though they were not computed in that order.

The comet's proper motion, the angle of the orbit and the ecliptic, and also the place of its intersection.

[Margin: Ex Diſtantiis.] (From the distances.)

Day of the month	By the corrected clock	Proper motion	Angle of orbit and ecliptic	Place of intersection, or node
20 December / 26 December	7^h 0^m 0^s *v.* / 9^h 0^m 34^s *v.*	46° 10′ 24″	73° 56′ 52″	58° 31′ 25″
20 December / 28 December	7^h 0^m 0^s *v.* / 1^h 34^m 10^s *m.*	50° 8′ 0″	73° 56′ 43″	58° 31′ 22″
20 December / 29 December	7^h 0^m 0^s *v.* / 4^h 55^m 32^s *m.*	52° 57′ 19″	73° 56′ 56″	58° 31′ 28″
20 December / 30 December	7^h 0^m 0^s *v.* / 6^h 10^m 30^s *v.*	56° 35′ 16″	74° 1′ 34″	58° 34′ 30″
20 December / 31 December	7^h 0^m 0^s *v.* / 4^h 15^m 16^s *m.*	57° 12′ 48″	74° 14′ 19″	58° 42′ 51″
20 December / 1 January	7^h 0^m 0^s *v.* / 2^h 52^m 49^s *m.*	58° 58′ 57″	74° 16′ 4″	58° 43′ 59″
20 December / 2 January	7^h 0^m 0^s *v.* / 6^h 27^m 30^s *v.*	60° 26′ 41″	74° 18′ 3″	58° 45′ 17″
20 December / 3 January	7^h 0^m 0^s *v.* / 6^h 47^m 30^s *v.*	62° 19′ 38″	74° 37′ 17″	58° 57′ 49″
20 December / 4 January	7^h 0^m 0^s *v.* / 2^h 3^m 24^s *m.*	62° 53′ 58″	74° 22′ 59″	58° 48′ 31″
20 December / 7 January	7^h 0^m 0^s *v.* / 2^h 26^m 9^s *m.*	65° 7′ 50″	75° 3′ 0″	59° 7′ 19″

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The comet's proper motion, the angle of the orbit and the ecliptic, and also the place of its intersection.

[Margin: Tam ex diſtantiis quàm ſimul ex altitudinibus & Azimuthis.] (Both from the distances and at the same time from the altitudes and azimuths.)

Day of the month	By the corrected clock	Proper motion	Angle of orbit and ecliptic	Place of intersection, or node
20 December / 23 December	7^h 0^m 0^s *v.* / 10^h 57^m 20^s *v.*	30° 25′ 10″	73° 57′ 43″	58° 31′ 57″
20 December / 26 December	7^h 0^m 0^s *v.* / 11^h 38^m 22^s *v.*	46° 27′ 20″	74° 0′ 50″	58° 34′ 0″

[209] each row of the table gives two days on two lines, the earlier (December 20) above the later, each with its time; the proper motion, the angle and the node stand once for the pair. The value columns are headed "Gr. Min. Sec." and the time column "Hor. Min. Sec."

Day of the month	By the corrected clock	Proper motion	Angle of orbit and ecliptic	Place of intersection, or node
20 December / 27 December	$7^h\ 0^m\ 0^s$ *v.* / $11^h\ 44^m\ 31^s$ *v.*	50° 2′ 40″	73° 53′ 30″	58° 29′ 13″
20 December / 29 December	$7^h\ 0^m\ 0^s$ *v.* / $4^h\ 28^m\ 50^s$ *m.*	52° 21′ 28″	74° 10′ 14″	58° 40′ 10″
20 December / 31 December	$7^h\ 0^m\ 0^s$ *v.* / $3^h\ 44^m\ 24^s$ *m.*	57° 2′ 1″	74° 1′ 21″	58° 34′ 20″
20 December / 1 January	$7^h\ 0^m\ 0^s$ *v.* / $3^h\ 26^m\ 0^s$ *m.*	59° 6′ 49″	74° 8′ 30″	58° 39′ 2″
20 December / 4 January	$7^h\ 0^m\ 0^s$ *v.* / $2^h\ 39^m\ 10^s$ *m.*	63° 43′ 28″	74° 12′ 27″	58° 41′ 37″
20 December / 4 January	$7^h\ 0^m\ 0^s$ *v.* / $2^h\ 59^m\ 30^s$ *m.*	62° 16′ 43″	74° 53′ 33″	59° 8′ 23″
20 December / 7 January	$7^h\ 0^m\ 0^s$ *v.* / $2^h\ 41^m\ 0^s$ *m.*	65° 15′ 39″	74° 53′ 34″	59° 8′ 23″

[Margin: Tam ex altitudinibus & Azimuthis, quàm diſtantiis.] (Both from the altitudes and azimuths and from the distances.)

Day of the month	By the corrected clock	Proper motion	Angle of orbit and ecliptic	Place of intersection, or node
23 December / 28 December	$10^h\ 57^m\ 20^s$ *v.* / $1^h\ 34^m\ 10^s$ *m.*	19° 41′ 18″	73° 54′ 28″	58° 31′ 51″
23 December / 30 December	$10^h\ 57^m\ 20^s$ *v.* / $6^h\ 10^m\ 30^s$ *v.*	26° 10′ 5″	74° 6′ 18″	58° 32′ 14″
23 December / 1 January	$10^h\ 57^m\ 20^s$ *v.* / $2^h\ 52^m\ 49^s$ *m.*	28° 34′ 3″	74° 36′ 34″	58° 33′ 13″
23 December / 2 January	$10^h\ 57^m\ 20^s$ *v.* / $6^h\ 27^m\ 30^s$ *v.*	30° 1′ 37″	74° 39′ 25″	58° 33′ 17″
23 December / 3 January	$10^h\ 57^m\ 20^s$ *v.* / $6^h\ 47^m\ 30^s$ *v.*	31° 54′ 53″	75° 16′ 3″	58° 34′ 29″
23 December / 4 January	$10^h\ 57^m\ 20^s$ *v.* / $2^h\ 3^m\ 24^s$ *m.*	32° 29′ 0″	74° 46′ 57″	58° 33′ 33″
23 December / 7 January	$10^h\ 57^m\ 20^s$ *v.* / $2^h\ 26^m\ 9^s$ *m.*	34° 42′ 40″	76° 0′ 39″	58° 35′ 55″

[Margin: Ex Altitudinibus & Azimuthis.] (From the altitudes and azimuths.)

Day of the month	By the corrected clock	Proper motion	Angle of orbit and ecliptic	Place of intersection, or node
23 December / 26 December	$10^h\ 57^m\ 20^s$ *v.* / $11^h\ 38^m\ 22^s$ *v.*	16° 2′ 8″	74° 7′ 15″	58° 32′ 16″
23 December / 27 December	$10^h\ 57^m\ 20^s$ *v.* / $11^h\ 44^m\ 31^s$ *v.*	19° 37′ 38″	73° 46′ 28″	58° 31′ 35″
23 December / 29 December	$10^h\ 57^m\ 20^s$ *v.* / $4^h\ 28^m\ 50^s$ *m.*	21° 56′ 20″	74° 29′ 7″	58° 32′ 59″
23 December / 31 December	$10^h\ 57^m\ 20^s$ *v.* / $3^h\ 44^m\ 24^s$ *m.*	26° 36′ 51″	74° 5′ 47″	58° 32′ 13″

Day of the month	By the corrected clock	Proper motion	Angle of orbit and ecliptic	Place of intersection, or node
23 December / 31 December	$10^h\ 57^m\ 20^s$ *v.* / $4^h\ 27^m\ 22^s$ *m.*	27° 7′ 40″	73° 55′ 58″	58° 31′ 54″
23 December / 1 January	$10^h\ 57^m\ 20^s$ *v.* / $2^h\ 20^m\ 43^s$ *m.*	28° 32′ 3″	74° 43′ 48″	58° 33′ 27″
23 December / 1 January	$10^h\ 57^m\ 20^s$ *v.* / $3^h\ 26^m\ 0^s$ *m.*	28° 41′ 43″	74° 20′ 30″	58° 32′ 52″
23 December / 4 January	$10^h\ 57^m\ 20^s$ *v.* / $2^h\ 39^m\ 10^s$ *m.*	33° 18′ 17″	74° 26′ 8″	58° 32′ 53″
23 December / 4 January	$10^h\ 57^m\ 20^s$ *v.* / $2^h\ 53^m\ 30^s$ *m.*	31° 52′ 10″	75° 48′ 14″	58° 35′ 31″

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[Margin: Cometa motum peregit inæqualem initiò velociorem, in fine tardiorem.] (The comet performed an unequal motion, swifter at the beginning, slower at the end.)

It is therefore plainly apparent that the comet had not only a proper motion in its own orbit, inclined at a definite angle to the ecliptic and the equator, but also a motion wholly unequal from the beginning of its appearance to the end. This was such that around the beginning, namely on December 20, it had a very swift motion; afterwards one somewhat slackened from day to day; and toward the end a quite slow one. Yet this motion, however entirely different it was on each single day, was not therefore irregular. On the contrary, it kept the highest regularity in that inequality, continually decreasing, as this proper motion clearly testifies, if it is weighed more exactly, in the preceding table, and likewise in the following one, where it was derived from right ascensions and declinations. For, first, it is certain that from the 20th at about 7^h in the evening to the 23rd at $10^h\ 57^m\ 20^s$ it completed 30° 25′ 16″ in its course. Secondly, from the 23rd to the 26th at $11^h\ 38^m\ 22^s$[211] it completed 16° 2′, or at most 3′. Thirdly, from the 26th to December 30, again 10° 21′[212]. Fourthly, from the 30th to January 4, only 6° 21′. Fifthly and lastly, from January 4 to the 7th of the same month it travelled no more than 2° 12′. Since this is so, it necessarily follows, especially if the whole calculation is considered and examined more scrupulously, that our phenomenon kept, on each single day, such a proportion of daily motion as I show in the adjoining little table. The beginning of this motion is assumed to be counted from December 20 at $10^h\ 57^m\ 20^s$ in the evening, so that each day is taken as completed at $10^h\ 57^m\ 20^s$ in the evening.

The comet's daily motion in its orbit.

[210] the page sets the table of p. 149 again under its caption and the same column heads, as one framed table; double rules divide it into the three groups given here, each with its side-note in the left margin beside its first rows. Each row gives two days on two lines, the earlier above the later, with the three values once for the pair. The value columns are headed "Gr.Min.Sec." and the time column "Hor.Min.Sec."

[211] the page marks the 38 with a double stroke, like the 22.

[212] the page sets no minute mark after the 21.

Day of the month	Motion
20 December	0° 0′
21	11° 16′
22	9° 23′
23 December	7° 46′
24	6° 24′
25	5° 17′
26 December	4° 22′
27	3° 34′
28	2° 47′
29 December	2° 10′
30	1° 50′
31	1° 35′
1 January	1° 24′
2	1° 15′
3	1° 7′
4 January	1° 0′
5	0° 52′
6	0° 44′
7 January	0° 36′
8	0° 29′

[213]

[Margin: Vt ut Cometa inæqualem, tamen regularem motum exercuit.] (Although the comet performed an unequal motion, it was nonetheless regular.)

And so you see that from the 20th to the 21st the comet completed 11° 16′ in its path, but from the 21st to the 22nd only 9° 23′, and so on; so much so that its motion decreased day by day, keeping due proportion, and around its last appearance amounted to barely thirty minutes. From this we safely conclude that the motion of our star was continually direct, but decreasing; never, however, stationary, much less retrograde, in its own path, that is, as has indeed been detected in some comets by careful investigators of celestial things.

But to make the motion of this phenomenon still more evident, here, in the following little table, is its continuous course for the single days, likewise beginning from $10^h\ 57^m\ 20^s$. From it will be clear in what proportion it advanced day by day, and how great an arc of a great circle of its path it travelled in the whole time of its duration, namely from December 20 at 7^h in the evening to January 8 at 11^h in the evening: namely 65° 51″.

It will also be no less pleasant than useful, especially in the business of parallaxes, as you will find in due course, if these two little tables of motions of the daily kind, extended to the single hours, are presented by us. Therefore, to do our duty all the more in this respect, I did not wish to shirk this labour too.

[213] the table stands at the left of the prose, its figure columns headed "Grad." and "Min."; rules divide the rows into groups of three and a last group of two, and the month name stands only on the first row of each group.

The comet's proper and continuous motion, in the track of its circle.

Day of the month	Hours, minutes, seconds	Motion
20 December	$7^h\ 0^m\ 0^s$	0° 0′
20	$10^h\ 57^m\ 20^s$	2° 0′
21		13° 16′
22 December	$10^h\ 57^m\ 20^s$	22° 39′
23		30° 25′
24		36° 49′
25 December	$10^h\ 57^m\ 20^s$	42° 6′
26		46° 28′
27		50° 2′
28 December	$10^h\ 57^m\ 20^s$	52° 49′
29		54° 59′
30		56° 49′
31 December	$10^h\ 57^m\ 20^s$	58° 24′
1 January		59° 48′
2		61° 3′
3 January	$10^h\ 57^m\ 20^s$	62° 10′
4		63° 10′
5		64° 2′
6 January	$10^h\ 57^m\ 20^s$	64° 46′
7		65° 22′
8		65° 51′

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But before we set these tables down here, let us present in one bundle that proper motion as derived from the declinations and right ascensions in the preceding section, together with the angle of inclination to the equator and the place of intersection. In this way it will at the same time be clear to anyone that we did not adopt this proportion of the daily and hourly motion rashly. For, as is evident, everything corresponds quite exactly, so that this motion scarcely ever departs, even by a single minute at most, from the earlier one computed from the longitudes and latitudes.

The comet's proper motion, the angle of the orbit and the equator, and also the place of its intersection.

[Margin: Ex Diſtantiis.] (From the distances.)

Day of the month	By the corrected clock	Proper motion	Angle of orbit and equator	Place of intersection, or node
20 December / 26 December	$7^h\ 0^m\ 0^s$ *v.* / $9^h\ 0^m\ 34^s$ *v.*	46° 10′ 2″	63° 0′ 44″	66° 53′ 29″

[214] the page sets this table in two halves side by side, the second half (from 28 December) with no caption or heads; rules divide the rows into groups of three, and the month name and the time stand only on the first row of each group (the first group gives two times). The heads read "Dies Menſ.", "Hor.Min.Sec." and "Grad.Min."

Day of the month	By the corrected clock	Proper motion	Angle of orbit and equator	Place of intersection, or node
20 December / 28 December	$7^h\ 0^m\ 0^s$ *v.* / $1^h\ 34^m\ 10^s$ *m.*	50° 6′ 6″	63° 0′ 22″	66° 53′ 25″
20 December / 29 December	$7^h\ 0^m\ 0^s$ *v.* / $4^h\ 55^m\ 32^s$ *m.*	52° 58′ 25″	63° 0′ 20″	66° 53′ 24″
20 December / 30 December	$7^h\ 0^m\ 0^s$ *v.* / $6^h\ 10^m\ 30^s$ *v.*	56° 34′ 16″	63° 6′ 1″	66° 54′ 29″
20 December / 31 December	$7^h\ 0^m\ 0^s$ *v.* / $4^h\ 15^m\ 16^s$ *m.*	57° 12′ 0″	63° 21′ 9″	66° 57′ 24″
20 December / 1 January	$7^h\ 0^m\ 0^s$ *v.* / $2^h\ 52^m\ 49^s$ *m.*	58° 57′ 1″	63° 23′ 0″	66° 57′ 45″
20 December / 2 January	$7^h\ 0^m\ 0^s$ *v.* / $6^h\ 27^m\ 30^s$ *v.*	60° 27′ 30″	63° 25′ 50″	66° 58′ 24″
20 December / 3 January	$7^h\ 0^m\ 0^s$ *v.* / $6^h\ 47^m\ 30^s$ *v.*	62° 18′ 39″	63° 47′ 58″	67° 2′ 32″
20 December / 4 January	$7^h\ 0^m\ 0^s$ *v.* / $2^h\ 3^m\ 24^s$ *m.*	62° 52′ 53″	63° 30′ 57″	66° 59′ 17″
20 December / 7 January	$7^h\ 0^m\ 0^s$ *v.* / $2^h\ 26^m\ 9^s$ *m.*	65° 6′ 5″	64° 18′ 1″	67° 8′ 13″

[Margin: Tam ex diſtantiis quàm ſimul ex altitudinibus & Azimuthis.] (Both from the distances and at the same time from the altitudes and azimuths.)

Day of the month	By the corrected clock	Proper motion	Angle of orbit and equator	Place of intersection, or node
20 December / 23 December	$7^h\ 0^m\ 0^s$ *v.* / $10^h\ 57^m\ 20^s$ *v.*	30° 24′ 17″	63° 1′ 7″	66° 53′ 33″
20 December / 26 December	$7^h\ 0^m\ 0^s$ *v.* / $11^h\ 38^m\ 27^s$ *v.*	46° 26′ 28″	63° 5′ 18″	66° 54′ 21″
20 December / 31 December	$7^h\ 0^m\ 0^s$ *v.* / $3^h\ 44^m\ 24^s$ *m.*	57° 1′ 14″	63° 6′ 0″	66° 54′ 28″
20 December / 1 January	$7^h\ 0^m\ 0^s$ *v.* / $3^h\ 26^m\ 0^s$ *m.*	59° 5′ 50″	63° 14′ 12″	66° 56′ 4″
20 December / 4 January	$7^h\ 0^m\ 0^s$ *v.* / $2^h\ 39^m\ 10^s$ *m.*	63° 42′ 36″	63° 18′ 55″	66° 56′ 59″

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Table of the comet's hourly motion.

[215] one framed table, divided by a double rule into the two groups given here, each with its side-note in the left margin beside its first rows. Each row gives two days on two lines, the earlier above the later, with the three values once for the pair. The value columns are headed "Gr.Min.Sec." and the time column "Hor.Min.Sec."; the angle column is headed "Angul. Orbit.& Æquatoris."

	Hour	20 December	21 December	22 December	23 December	24 December	25 December	26 December	27 December	28 December	29 December
Hours before noon	12		0° 30′	0° 26′	0° 21′	0° 17′	0° 14′	0° 12′	0° 10′	0° 8′	0° 6′
	1		1° 0′	0° 52′	0° 42′	0° 34′	0° 28′	0° 24′	0° 20′	0° 16′	0° 12′
	2		1° 30′	1° 18′	1° 3′	0° 51′	0° 42′	0° 36′	0° 30′	0° 24′	0° 18′
	3		1° 59′	1° 43′	1° 24′	1° 8′	0° 56′	0° 48′	0° 40′	0° 32′	0° 24′
	4		2° 28′	2° 8′	1° 44′	1° 25′	1° 10′	1° 0′	0° 50′	0° 40′	0° 30′
	5		2° 57′	2° 33′	2° 4′	1° 42′	1° 24′	1° 12′	1° 0′	0° 48′	0° 36′
	6		3° 26′	2° 58′	2° 24′	1° 59′	1° 38′	1° 24′	1° 9′	0° 56′	0° 42′
	7		3° 55′	3° 23′	2° 44′	2° 16′	1° 52′	1° 36′	1° 18′	1° 3′	0° 48′
	8		4° 24′	3° 47′	3° 4′	2° 32′	2° 6′	1° 47′	1° 27′	1° 10′	0° 54′
	9		4° 52′	4° 11′	3° 24′	2° 48′	2° 20′	1° 58′	1° 36′	1° 17′	1° 0′
	10		5° 20′	4° 35′	3° 44′	3° 4′	2° 33′	2° 9′	1° 45′	1° 24′	1° 5′
	11		5° 48′	4° 59′	4° 4′	3° 20′	2° 46′	2° 20′	1° 54′	1° 31′	1° 10′
Hours after noon	12		6° 16′	5° 22′	4° 23′	3° 36′	2° 59′	2° 31′	2° 3′	1° 38′	1° 15′
	1		6° 44′	5° 45′	4° 42′	3° 52′	3° 12′	2° 42′	2° 12′	1° 45′	1° 20′
	2		7° 12′	6° 8′	5° 1′	4° 8′	3° 25′	2° 53′	2° 21′	1° 52′	1° 25′
	3		7° 40′	6° 31′	5° 20′	4° 24′	3° 38′	3° 4′	2° 30′	1° 59′	1° 30′
	4		8° 7′	6° 53′	5° 39′	4° 40′	3° 51′	3° 14′	2° 38′	2° 5′	1° 35′
	5		8° 34′	7° 15′	5° 58′	4° 56′	4° 4′	3° 24′	2° 46′	2° 11′	1° 40′
	6		9° 11′	7° 37′	6° 16′	5° 11′	4° 17′	3° 34′	2° 54′	2° 17′	1° 45′
	7	0° 0′	9° 28′	7° 59′	6° 34′	5° 26′	4° 29′	3° 44′	3° 2′	2° 23′	1° 50′
	8	0° 30′	9° 55′	8° 20′	6° 52′	5° 41′	4° 41′	3° 54′	3° 10′	2° 29′	1° 55′
	9	1° 0′	10° 22′	8° 41′	7° 10′	5° 56′	4° 53′	4° 4′	3° 18′	2° 35′	2° 0′
	10	1° 30′	10° 49′	9° 2′	7° 28′	6° 10′	5° 5′	4° 13′	3° 26′	2° 41′	2° 5′
	11	2° 0′	11° 16′	9° 23′	7° 46′	6° 24′	5° 17′	4° 22′	3° 34′	2° 47′	2° 10′

	Hour	30 December	31 December	1 January	2 January	3 January	4 January	5 January	6 January	7 January	8 January
Hours before noon	12	0° 5′	0° 4′	0° 4′	0° 4′	0° 3′	0° 2½′	2′ 10″	2′ 0″	1′ 30″	1′ 30″
	1	0° 10′	0° 8′	0° 8′	0° 8′	0° 6′	0° 5′	4′ 20″	4′ 0″	3′ 0″	3′ 0″
	2	0° 15′	0° 12′	0° 12′	0° 12′	0° 9′	0° 7½′	6′ 30″	6′ 0″	4′ 30″	4′ 30″
	3	0° 20′	0° 16′	0° 16′	0° 15′	0° 12′	0° 10′	8′ 40″	8′ 0″	6′ 0″	6′ 0″
	4	0° 25′	0° 20′	0° 20′	0° 18′	0° 15′	0° 12½′	10′ 50″	10′ 0″	7′ 30″	7′ 30″
	5	0° 30′	0° 24′	0° 24′	0° 21′	0° 18′	0° 15′	13′ 0″	12′ 0″	9′ 0″	9′ 0″
	6	0° 35′	0° 28′	0° 28′	0° 24′	0° 21′	0° 17½′	15′ 10″	14′ 0″	10′ 30″	10′ 30″
	7	0° 40′	0° 32′	0° 32′	0° 27′	0° 24′	0° 20′	17′ 20″	16′ 0″	12′ 0″	12′ 0″
	8	0° 45′	0° 36′	0° 36′	0° 30′	0° 27′	0° 22½′	19′ 30″	18′ 0″	13′ 30″	13′ 30″
	9	0° 50′	0° 40′	0° 40′	0° 33′	0° 30′	0° 25′	21′ 40″	20′ 0″	15′ 0″	15′ 0″
	10	0° 55′	0° 44′	0° 44′	0° 36′	0° 33′	0° 27½′	23′ 50″	22′ 0″	16′ 30″	16′ 0″
	11	1° 0′	0° 48′	0° 48′	0° 39′	0° 36′	0° 30′	26′ 0″	24′ 0″	18′ 0″	17′ 0″

	Hour	30 December	31 December	1 January	2 January	3 January	4 January	5 January	6 January	7 January	8 January
Hours after noon	12	1° 5′	0° 52′	0° 51′	0° 42′	0° 39′	0° 32½′	28′ 10″	26′ 0″	19′ 30″	18′ 0″
	1	1° 10′	0° 56′	0° 54′	0° 45′	0° 42′	0° 35′	30′ 20″	28′ 0″	21′ 0″	19′ 0″
	2	1° 14′	1° 0′	0° 57′	0° 48′	0° 44½′	0° 37½′	32′ 30″	30′ 0″	22′ 30″	20′ 0″
	3	1° 18′	1° 4′	1° 0′	0° 51′	0° 47′	0° 40′	34′ 40″	32′ 0″	24′ 0″	21′ 0″
	4	1° 22′	1° 8′	1° 3′	0° 54′	0° 49½′	0° 42½′	36′ 50″	33′ 30″	25′ 30″	22′ 0″
	5	1° 26′	1° 12′	1° 6′	0° 57′	0° 52′	0° 45′	39′ 0″	35′ 0″	27′ 0″	23′ 0″
	6	1° 30′	1° 16′	1° 9′	1° 0′	0° 54½′	0° 47½′	41′ 10″	36′ 30″	28′ 30″	24′ 0″
	7	1° 34′	1° 20′	1° 12′	1° 3′	0° 57′	0° 50′	43′ 20″	38′ 0″	30′ 0″	25′ 0″
	8	1° 38′	1° 24′	1° 15′	1° 6′	0° 59½′	0° 52½′	45′ 30″	39′ 30″	31′ 30″	26′ 0″
	9	1° 42′	1° 28′	1° 18′	1° 9′	1° 2′	0° 55′	47′ 40″	41′ 0″	33′ 0″	27′ 0″
	10	1° 46′	1° 32′	1° 21′	1° 12′	1° 4½′	0° 57½′	49′ 50″	42′ 30″	34′ 30″	28′ 0″
	11	1° 50′	1° 35′	1° 24′	1° 15′	1° 7′	1° 0′	52′ 0″	44′ 0″	36′ 0″	29′ 0″

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The comet's proper motion, extended to the single days and hours of its whole duration.

	Hour	20 December	21 December	22 December	23 December	24 December	25 December	26 December	27 December	28 December	29 December
Hours before noon	12		2° 30′	13° 42′	23° 0′	30° 42′	37° 3′	42° 18′	46° 38′	50° 10′	52° 55′
	1		3° 0′	14° 8′	23° 21′	30° 59′	37° 17′	42° 30′	46° 48′	50° 18′	53° 1′
	2		3° 30′	14° 34′	23° 42′	31° 16′	37° 31′	42° 42′	46° 58′	50° 26′	53° 7′
	3		3° 59′	14° 59′	24° 3′	31° 33′	37° 45′	42° 54′	47° 8′	50° 34′	53° 13′
	4		4° 28′	15° 24′	24° 23′	31° 50′	37° 59′	43° 6′	47° 18′	50° 42′	53° 19′
	5		4° 57′	15° 49′	24° 43′	32° 7′	38° 13′	43° 18′	47° 28′	50° 50′	53° 25′
	6		5° 26′	16° 14′	25° 3′	32° 24′	38° 27′	43° 30′	47° 37′	50° 58′	53° 31′
	7		5° 55′	16° 39′	25° 23′	32° 41′	38° 41′	43° 42′	47° 46′	51° 5′	53° 37′
	8		6° 24′	17° 3′	25° 43′	32° 57′	38° 55′	43° 53′	47° 55′	51° 12′	53° 43′
	9		6° 52′	17° 27′	26° 3′	33° 13′	39° 9′	44° 4′	48° 4′	51° 19′	53° 49′
	10		7° 20′	17° 51′	26° 23′	33° 29′	39° 22′	44° 15′	48° 13′	51° 26′	53° 54′
	11		7° 48′	18° 15′	26° 43′	33° 45′	39° 35′	44° 26′	48° 22′	51° 33′	53° 59′

[216] one framed table, divided by a double rule into the two halves given here, each with its own head row. Each day column is headed "Die N" over "Dec.Cur." or "Jan.Cur." (of the current December or January) and over the units of its two figures: "Gr.Min." (degrees, minutes) in the first sixteen columns, "Mi. Sec." (minutes, seconds) in the last four, 5 to 8 January. "Horâ" (at the hour) heads the hour column. The labels for hours before noon (printed in the pieces "Ho", "ræ ante", "meridia", "næ."; "ræ ante-" in the lower half) and for hours after noon ("Ho", "ræ poſt-", "meridia", "næ.") are set sideways in a narrow column at the left, each beside its run of twelve hours. The column for 20 December is blank from 12 before noon to 6 after noon. Rules divide the rows into groups of three.

	Hour	20 December	21 December	22 December	23 December	24 December	25 December	26 December	27 December	28 December	29 December
Hours after noon	12		8° 16′	18° 38′	27° 2′	34° 1′	39° 48′	44° 37′	48° 31′	51° 40′	54° 4′
	1		8° 44′	19° 1′	27° 21′	34° 17′	40° 1′	44° 48′	48° 40′	51° 47′	54° 9′
	2		9° 12′	19° 24′	27° 40′	34° 33′	40° 14′	44° 59′	48° 49′	51° 54′	54° 14′
	3		9° 40′	19° 47′	27° 59′	34° 49′	40° 27′	45° 10′	48° 58′	52° 1′	54° 19′
	4		10° 7′	20° 9′	28° 18′	35° 5′	40° 40′	45° 20′	49° 6′	52° 7′	54° 24′
	5		10° 34′	20° 31′	28° 37′	35° 21′	40° 53′	45° 30′	49° 14′	52° 13′	54° 29′
	6		11° 11′	20° 53′	28° 55′	35° 36′	41° 6′	45° 40′	49° 22′	52° 19′	54° 34′
	7	0° 0′	11° 28′	21° 15′	29° 13′	35° 51′	41° 18′	45° 50′	49° 30′	52° 25′	54° 39′
	8	0° 30′	11° 55′	21° 36′	29° 31′	36° 6′	41° 30′	46° 0′	49° 38′	52° 31′	54° 44′
	9	1° 0′	12° 22′	21° 57′	29° 49′	36° 21′	41° 42′	46° 10′	49° 46′	52° 37′	54° 49′
	10	1° 30′	12° 49′	22° 18′	30° 7′	36° 35′	41° 54′	46° 19′	49° 54′	52° 43′	54° 54′
	11	2° 0′	13° 16′	22° 39′	30° 25′	36° 49′	42° 6′	46° 28′	50° 2′	52° 49′	54° 59′

	Hour	30 December	31 December	1 January	2 January	3 January	4 January	5 January	6 January	7 January	8 January
Hours before noon	12	55° 4′	56° 53′	58° 28′	59° 52′	61° 6′	62° 12½′	63° 12⅙′	64° 4′	64° 47½′	65° 23½′
	1	55° 19′	56° 57′	58° 32′	59° 56′	61° 9′	62° 15′	63° 14⅓′	64° 6′	64° 49′	65° 25′
	2	55° 14′	57° 1′	58° 36′	60° 0′	61° 12′	62° 17½′	63° 16½′	64° 8′	64° 50½′	65° 26½′
	3	55° 19′	57° 5′	58° 40′	60° 3′	61° 15′	62° 20′	63° 18⅔′	64° 10′	64° 52′	65° 28′
	4	55° 24′	57° 9′	58° 44′	60° 6′	61° 18′	62° 22½′	63° 20⅚′	64° 12′	64° 53½′	65° 29½′
	5	55° 29′	57° 13′	58° 48′	60° 9′	61° 21′	62° 25′	63° 23′	64° 14′	64° 55′	65° 31′
	6	55° 34′	57° 17′	58° 52′	60° 12′	61° 24′	62° 27½′	63° 25⅙′	64° 16′	64° 56½′	65° 32½′
	7	55° 39′	57° 21′	58° 56′	60° 15′	61° 27′	62° 30′	63° 27⅓′	64° 18′	64° 58′	65° 34′
	8	55° 44′	57° 25′	59° 0′	60° 18′	61° 30′	62° 32½′	63° 29½′	64° 20′	64° 59½′	65° 35½′
	9	55° 49′	57° 29′	59° 4′	60° 21′	61° 33′	62° 35′	63° 31⅔′	64° 22′	65° 1′	65° 37′
	10	55° 54′	57° 33′	59° 8′	60° 24′	61° 36′	62° 37½′	63° 33⅚′	64° 24′	65° 2½′	65° 38′
	11	55° 59′	57° 37′	59° 12′	60° 27′	61° 39′	62° 40′	63° 36′	64° 26′	65° 4′	65° 39′
Hours after noon	12	56° 4′	57° 41′	59° 15′	60° 30′	61° 42′	62° 42½′	63° 38⅙′	64° 28′	65° 5½′	65° 40′
	1	56° 9′	57° 45′	59° 18′	60° 33′	61° 45′	62° 45′	63° 40⅓′	64° 30′	65° 7′	65° 41′
	2	56° 13′	57° 49′	59° 21′	60° 36′	61° 47½′	62° 47½′	63° 42½′	64° 32′	65° 8½′	65° 42′
	3	56° 17′	57° 53′	59° 24′	60° 39′	61° 50′	62° 50′	63° 44⅔′	64° 34′	65° 10′	65° 43′
	4	56° 21′	57° 57′	59° 27′	60° 42′	61° 52½′	62° 52½′	63° 46⅚′	64° 35½′	65° 11½′	65° 44′
	5	56° 25′	58° 1′	59° 30′	60° 45′	61° 55′	62° 55′	63° 49′	64° 37′	65° 13′	65° 45′
	6	56° 29′	58° 5′	59° 33′	60° 48′	61° 57½′	62° 57½′	63° 51⅙′	64° 38½′	65° 14½′	65° 46′
	7	56° 33′	58° 9′	59° 36′	60° 51′	62° 0′	63° 0′	63° 53⅔′	64° 40′	65° 16′	65° 47′
	8	56° 37′	58° 13′	59° 39′	60° 54′	62° 2½′	63° 2½′	63° 55½′	64° 41½′	65° 17½′	65° 48′
	9	56° 41′	58° 17′	59° 42′	60° 57′	62° 5′	63° 5′	63° 57⅔′	64° 43′	65° 19′	65° 49′
	10	56° 45′	58° 21′	59° 45′	61° 0′	62° 7½′	63° 7½′	63° 59⅚′	64° 44½′	65° 20½′	65° 50′
	11	56° 49′	58° 24′	59° 48′	61° 3′	62° 10′	63° 10′	64° 2′	64° 46′	65° 22′	65° 51′

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Now that the comet's proper motion has been properly determined in this way, it follows that we should examine with equal care the angle between the orbit and the ecliptic. As we said above, this angle was not of quite the same size throughout the whole time the comet shone, as the table inserted on page 106 shows. At the start, on 23 December, it was 73° 59′; it then decreased gradually up to the 27th; from that day it increased again, though not altogether evenly, but more and more from day to day, while still keeping a certain fixed proportion, up to 7 January, when it was found at its greatest of all, namely 75° and 3′.

[Margin: Quâ ratione Angulus Orbitæ & Eclipticæ variatus fuerit?] *In what way the angle between the orbit and the ecliptic varied.*

Very nearly the same kind of motion appeared about the point of intersection of the comet's orbit and the ecliptic, that is, the comet's northern node [Nodum Boreum]. From the beginning up to 27 December it moved with a retrograde motion, though a scarcely perceptible one; after that it took on a direct motion, and one that grew gradually faster. Considering the matter somewhat more exactly, and examining all the calculations of this angle and of the node carefully, we noticed that on 23 December the node lay in ♉ 28° 33′; on the 26th and 27th in ♉ 28° 31′, where it stayed as if at a station; but on 7 January in ♉ 29° 7′. So the difference of this variation, counted from that station, came to 36 minutes.

[Margin: De motu hujus Cometæ Nodi Borei.] *On the motion of this comet's northern node.*

Likewise the angle was at its smallest of all around 26 and 27 December, namely 73° 57′, and at its greatest of all around the comet's disappearance, so that the difference of this angle grew to 1° 6′. This is clearer from the attached table, in which we have chosen to set out the variation for every day, both of the angle and of the place of intersection.

[Margin: Quanta variatio anguli Eclipticæ & Orbitæ extiterit.] *How great the variation of the angle between the ecliptic and the orbit was.*

Table showing the variation of the angle between the comet's orbit and the ecliptic, and also the motion of its northern node, for each single day.

[217] one framed table, divided by a double rule into the two halves given here, each with its own head row, laid out as the table of hourly motion on the facing page. Each day column is headed "Die N" over "Dec.Cur." or "Jan.Cur." and over "Gr.Min." (degrees, minutes) or a variant of it; "Horâ" heads the hour column; the labels for hours before and after noon stand sideways at the left, split by the rules into the same pieces as on p. 153. The column for 20 December is blank from 12 before noon to 6 after noon. Rules divide the rows into groups of three. The fractions are set as a small numerator above a small denominator.

Month, day; year 1652	Angle of the comet's orbit and the ecliptic (degrees, minutes)	Dif-fer-ence	Northern node (degrees, minutes)	Sign	Dif-fer-ence
December 23	73° 59′		28° 33′	♉	
		1			1
24	73° 58′		28° 32′	♉	
		½			½
25	73° 57½′		28° 31½′	♉	
		½			½
December 26	73° 57′		28° 31′	♉	
		0			0
27	73° 57′		28° 31′	♉	
		½			0
28	73° 57½′		28° 31′	♉	
		1½			1
December 29	73° 59′		28° 32′	♉	
		3			2
30	74° 2′		28° 34′	♉	
		5			2
31	74° 7′		28° 36′	♉	
		5			3
January 1	74° 12′		28° 39′	♉	
		6			3
2 (year 1653)	74° 18′		28° 42′	♉	
		7			3
3	74° 25′		28° 45′	♉	
		8			4
January 4	74° 33′		28° 49′	♉	
		9			5
5	74° 42′		28° 54′	♉	
		10			6
6	74° 52′		29° 0′	♉	
		11			7
January 7	75° 3′		29° 7′	♉	

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Although I do not think anyone can still doubt the certainty of this motion, especially if one weighs carefully with how much diligence, and from how many and how varied examples, we derived it, computing it not only from the observed distances of the comet from the fixed stars but also, with by far the

[218]a framed table set at the left of the text, which runs on beside it. The date column is headed "Menſ. Dies" over "Ann.1652." (month, day; year 1652), and "A.1653" (year 1653) stands in it beside 2 January. The angle column is headed "Angul.Orb. Com. & Ecl." over "Grad. Min.", the node column "Nodus Bor." over "Gr. Min. S." (degrees, minutes, sign); each difference column is headed "differ" alone, with no unit. Each pair of difference figures is printed on a half-line between the two dated rows it separates, and is given here on a row of its own in the same place. Rules divide the dated rows into groups of three, 7 January standing alone below the last rule.

greatest diligence, from the comet's altitudes and azimuths, let us nevertheless, for the sake of a fuller investigation, see whether the angle between the comet's orbit and the equator, together with its node, also underwent some change or anomaly. If it grew in the same way as the angle between the orbit and the ecliptic (keeping, however, the due proportion with respect to the inclination of the equator to the ecliptic), that is a further sure sign that everything truly stands as we said above about the angle of inclination to the ecliptic.

[Margin: Et angulus Orbitæ & Æquatoris nec non Nodus var.ationi fuit obnoxius.] *The angle between the orbit and the equator, and the node too, were also subject to variation.*

Having therefore carefully weighed the angle of intersection with the equator and its node, derived in Section IX and set out on page 108, we found that near the start of the appari- tion the angle of inclination to the equator was slightly diminished, but from the 27th or 28th was gradually increased again. The same thing happened likewise with its node. At first it was carried toward the preceding signs [in antecedentia], but with a scarcely perceptible motion; then, after making a station, it became direct, though advancing at the slowest pace, as the attached small table sets out. In it we have chosen to record, for each single day of the whole apparition, both the decrease and the increase of the angle, and also the anomaly of the node, as exactly as was possible.

From the table it is plain that on 26 December this angle was 63° 0′ 44″; that around the station it did become smaller by a few minutes; but that afterwards it grew again, up to the comet's extinction, at which time it was found to be about 64° and 18′. The difference in the variation of the angle was therefore 1° 18′, whereas the difference of this node scarcely grew to 15′.

[Margin: Magnitudo anguli, ejusq́; variatio.] *The size of the angle, and its variation.*

Table showing the variation of the angle between the comet's orbit and the equator, and also the motion of its northern node, for each single day.

Year 1652; month, day	Angle of the comet's orbit and the equator (degrees, minutes, seconds)	Difference (minutes)	Northern node (degrees, minutes, seconds)	Difference (minutes)
December 26	63° 0′ 44″		66° 53′ 29″	
27	63° 0′ 33″		66° 53′ 27″	
28	63° 0′ 22″		66° 53′ 25″	
December 29	63° 0′ 20″		66° 53′ 24″	
		5		1
30	63° 6′ 0″		66° 55′ 0″	
		5		1
31	63° 11′ 0″		66° 56′ 0″	
		6		1½
January 1	63° 17′ 0″		66° 57′ 30″	

Year 1652; month, day	Angle of the comet's orbit and the equator (degrees, minutes, seconds)	Difference (minutes)	Northern node (degrees, minutes, seconds)	Difference (minutes)
		7		1½
2	63° 24′ 0″		66° 59′ 0″	
		8		2
3	63° 32′ 0″		67° 1′ 0″	
		9		2
4	63° 41′ 0″		67° 3′ 0″	
		11		2
January 5	63° 52′ 0″		67° 5′ 0″	
		12		2
6	64° 4′ 0″		67° 7′ 0″	
		14		1½
January 7	64° 18′ 0″		67° 8′ 13″	

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To anyone asking why the node of the comet's orbit and the equator did not acquire quite the same difference as the node of the comet's orbit and the ecliptic, namely 36 minutes, the answer is this: since the comet's orbit cut the equator more obliquely, because of its greater obliquity with respect to the ecliptic, the motion of the point of intersection with the equator was necessarily slower as well, and so it could not follow a similar pattern of variation.

We have therefore sufficiently demonstrated that these angles, and likewise the places of the nodes, changed in a certain fixed way, even though I have no one to support me on this point. But why did none of all the other observers notice this as well? I will tell you. First, some of them no doubt imagined that no motion could occur in this angle, especially if, as many believe, they move in a great circle; and, led by this preconceived opinion, they settled on that angle as derived from only one or two examples. Others, lacking many suitable observations, could detect scarcely any perceptible change. For you should know that very many and very certain observations are needed to investigate such extremely subtle matters; with observations obtained in the common way, for instance by stretched threads, or with cruder instruments, these things can by no means be investigated. And since very few have drawn such observations from the sky, it was not granted to them to perceive the motion of the angle so often mentioned, and of the node.

[219] a framed table set at the right of the text, which runs on beside it. The date column is headed "Ann.1652." over "Menſ. Dies" (year 1652; month, day). The angle column is headed "Angul. Orb." over "Com. & Æq." over "Gr.Min.Sec.", the node column "Nodus Bor." over "Gr. Min.Sec."; each difference column is headed "differ" over "Min." (minutes). Each pair of difference figures is printed on a half-line between the two dated rows it separates, and is given here on a row of its own in the same place; none stands between 26, 27, 28 and 29 December. Rules divide the dated rows into groups of three, 7 January standing alone below the last rule.

[Margin: Cur nemo omnium, præter autorem, motum anguli Eclipticæ & Orbitæ, nec non Nodi animadverterit?] *Why no one but the author noticed the motion of the angle between the ecliptic and the orbit, and of the node.*

Furthermore, this occasion raises a question, and not without reason: whether phenomena of this kind also occurred, and were detected, in all the remaining comets, or only in some. Since this question has not yet, as far as I know, occurred to astronomers [Aſtroſophis], it deserves, believe me, to be fully

[Margin: An omnes & ſinguli Cometæ ſimilem referant motum?] *Whether each and every comet shows a similar motion.*

investigated: and this I now gladly set about doing. To begin with, however, I shall first lay my own view of the matter before you. To tell the truth, I am fully resolved that this variation of the angle of inclination of the orbit, and of the point of intersection, has always been common to all comets, though with an entirely different manner of motion, as we shall explain at greater length below.

It may indeed be objected that astronomers by no means the least — that noble investigator of the heavens and the stars, Tycho Brahe, for the comets of 1577 and 1590; Willebrordum Snellium [Willebrord Snel] and Peter Crüger for the comet of 1618; and, not to mention others, most distinguished men — found and established exactly the opposite. Just as these men were by far the most practised in observing and investigating celestial things, and the most ingenious, so that scarcely anyone can be ranked equal with them in this business, let alone above them — above all Tycho, whose supreme diligence in measuring the phenomena of the heavens, and whose keenness and penetration of intellect and judgement, the whole learned world rightly looks up to and celebrates — so I myself judge this objection to be weighty indeed. We shall therefore do rightly, and very well, if we inquire somewhat more carefully into their opinion.

[Margin: Quinam inter Autores circa Cometas fixum angulum Orbitæ, & Nodum ſtatuerint?] *Which of the authors held that the angle of the orbit, and the node, are fixed in comets.*

First, as regards Tycho, I very readily grant that in Chapter V, on the comet of 1577, he showed from seven different and duly computed examples that the angle of inclination to the ecliptic was of the same size, namely 29° 15′, and that the point of intersection lay, through all the days the comet shone, in ♐ 20° 55′, as is clear from this small table. The first column contains the observations of those days from which Tycho himself derived the angle and the node; the second, the longitudes; the third, the comet's latitudes; and the fourth and fifth, the angle and the node.

[Margin: Tycho, diverſis exemplis in Cometâ an. 1577. oſtendit angulum inclinationis invariabilem extitisſe.] *Tycho showed by various examples, in the comet of 1577, that the angle of inclination was invariable.*

Angle of inclination to the ecliptic, and the node, of the comet of 1577, according to Tycho's calculation.

Year 1577; month, day	Longitude of the comet	Latitude of the comet	Angle of inclination	Node
November 23	3° 31′ ♒	20° 45′ *B*		
			29° 13′	20° 52′ ♐
January 2	10° 54′ ♐	28° 51′ *B*		
November 13	7° 15′ ♑	8° 59′ *B*		
			29° 13′	20° 51′ ♐
January 12	15° 37′ ♓	29° 10′ *B*		
November 25	7° 24′ ♒	22° 6′ *B*		
			29° 13′	20° 51′ ♐
December 31	9° 54′ ♓	28° 46′ *B*		
November 20	26° 59′ ♑	18° 15′ *B*		
			29° 13′	20° 51′ ♐
January 5	12° 24′ ♓	28° 57′ *B*		
November 15	13° 46′ ♑	12° 14′ *B*		
			29° 13′	20° 57′ ♐
January 9	14° 15′ ♓	29° 3′ *B*		
November 21	29° 16′ ♑	19° 6′ *B*		
			29° 15′	21° 3′ ♐
January 1	10° 22′ ♓	28° 49′ *B*		
November 14	10° 38′ ♑	10° 39′ *B*		
			29° 13′	20° 58′ ♐
December 30	9° 14′ ♓	28° 42′ *B*		

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Moreover, in Chapter VI, where he examines the said angle in turn, he insists again and again that this comet, by its proper motion, described a circle in the sphe- re that was exactly a great circle, held midway between its own poles, and that in the whole time it lasted it never deviated from that circle to one side or the other. Above all, on page 103, he concludes in these words: *It is therefore plain and sufficiently proven — the very thing we asserted from the beginning — first, that the comet by its motion described an exactly great circle, dividing the sphere into two equal halves; for everywhere the angle of inclination of the comet's circle to the ecliptic remained of the same size, namely 29° 15′. That it sometimes varied by two*

[220] a framed, ruled table in the body's measure. The date column is headed "Anno 1577" over "Menſ. Dies" (year 1577; month, day); the longitude column "Long. Com." over "Gr.Min. S." (degrees, minutes, sign); the latitude column "Latit. Com." over "Grad.Min."; the angle column "Angulus inclin." over "Grad. Min."; the node column "Nodus." over "Grad. Min. S.". The table is ruled into seven groups, each of two dated rows, a November date over a December or January date; the angle and node of each group are printed once, centred on the half-line between its two dated rows, and are given here on a row of their own in the same place. The page sets "B" after every latitude, unexpanded. On 2 January the page sets the Sagittarius sign after the longitude 10° 54′, where every other December and January row carries the Pisces sign.

or three, or at most five minutes (which nevertheless rarely happened), will easily be excused by those who understand, and will be counted as nothing. Therefore, since the inclination of the comet's path to the ecliptic is found to be the same everywhere throughout the whole time of its apparition, those in doubt will not be hard to persuade — provided they understand the principle of the circles of the sphere — that the arc the comet described by its motion is a portion of a great circle in the sphere, no less than the ecliptic, toward which it everywhere kept the size of the same angle; and that it had its own poles and stood equally distant from them, as the ecliptic does from its own; in the same way as the equator and the ecliptic stand in a mutual relation with respect to their poles, and although they intersect each other, each nevertheless, by reason of its own pole, describes a great circle in the sphere.

[Margin: Cometa anni 1577 in circulo incesſit maximo.] *The comet of 1577 moved in a great circle.*

And so it is perfectly true that Tycho firmly believed the angle of inclination was always equal, and that the node stayed fixed at the same point of the ecliptic. But I, with all respect to the honour of that great man, think quite otherwise: namely, that the said angle increased gradually from the beginning of the apparition up to its end, and likewise that the node advanced in the order of the signs, though very slowly, as I shall shortly demonstrate clearly by solid arguments. You are not, however, to suppose that I wish to call either Tycho's observations or his calculations into question — far be it, far be it indeed! For I know very well that in this study, and especially in cometography [Cometographico], he had scarcely anyone his equal; and indeed that more diligent and more certain observations, and more accurate calculations, can hardly ever be had. All we find wanting is this: that he did not seek this angle in order, as it ought to have been done, and as we advised above. For he set up the computation of this same angle of inclination only for some intermediate days, namely from 30 December to 12 January, whereas he ought to have investigated it for all the days of its shining, the first as well as the last, that is, from the middle of November up to the end of January; and to have done so in such a way that in every calculation he bound the observations of all the remaining days to one observation made near the beginning of the comet's apparition and more certain than the rest — as we did above with our own comet.

[Margin: Autor contra opinionem Tychonis ſtatuit angulum inclinationis Cometæ iſtius continuò crevisſe.] *Against Tycho's opinion, the author holds that this comet's angle of inclination increased continually.*

[Margin: Judicium Autoris de Tychonis obſervationibus.] *The author's judgement of Tycho's observations.*

Therefore, so that we may get to the bottom of this business more successfully, I have chosen to examine afresh, by our own method and without regard to the trouble of the labour, the said angle between the orbit and the ecliptic, and also the node, of the comet of 1577, keeping as a standard in every investigation the first observation, made by Tycho on 13 November. But so as

not to burden you with laborious calculation, let us set out only the givens and the results, at a single glance, in a small table.

[Margin: Angulus orbitæ & Eclipticæ ab Autore denuò inveſtigatus.] *The angle between the orbit and the ecliptic investigated afresh by the author.*

Angle of inclination to the ecliptic, and the node, of the comet of 1577, according to Hevelius's calculation.

Year 1577; month, day	Longitude of the comet	Latitude of the comet	Angle of inclination	Node
November 13	7° 15′ ♍	8° 59′ *B*		
			29° 10′	20° 48′ ♐
November 20	26° 59′ ♍	18° 15′ *B*		
November 13	7° 15′ ♍	8° 59′ *B*		
			29° 11′	20° 48′ ♐
November 23	3° 31′ ♒	20° 45′ *B*		
November 13	7° 15′ ♍	8° 59′ *B*		
			29° 11′	20° 48′ ♐
December 10	25° 47′ ♒	26° 50′ *B*		
November 13	7° 15′ ♍	8° 59′ *B*		
			29° 11′	20° 49′ ♐
December 17	1° 17′ ♓	27° 46′ *B*		
November 13	7° 15′ ♍	8° 59′ *B*		
			29° 13′	20° 50′ ♐
December 30	9° 14′ ♓	28° 42′ *B*		
November 13	7° 15′ ♍	8° 59′ *B*		
			29° 13′	20° 50′ ♐
January 9	14° 15′ ♓	29° 3′ *B*		
November 13	7° 15′ ♍	8° 59′ *B*		
			29° 16′	20° 52′ ♐
January 16	18° 8′ ♓	29° 14′ *B*		
November 13	7° 15′ ♍	8° 59′ *B*		
			29° 19′	20° 54′ ♐
January 26	20° 15′ ♓	29° 18′ *B*		

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So you see that the angle of inclination to the ecliptic was only 29° 10′ on 20 November, but that it then increased gradually up to 26 January, at which time it was 29° 19′, so that the difference over the whole duration was 9 minutes. Tycho, however, since he computed the said angle only for the end of December and about the beginning of January, that is, for the intermediate

[221] a framed, ruled table at the head of the page, headed as the table on p. 157: "Anno 1577" over "Menſ. Dies"; "Long. Com." over "Gr.Min. S."; "Latit. Com." over "Grad.Min."; "Angulus inclin." over "Grad. Min."; "Nodus." over "Grad. Min. S.". It is ruled into eight groups, each pairing the observation of 13 November with one later observation; the angle and node of each group are printed once, centred on the half-line between its two dated rows, and are given here on a row of their own in the same place. The page sets "B" after every latitude, unexpanded.

time, found it to be 29° 13′; and that is indeed the size it truly had, as my own calculation also attests. But near the beginning, around 20 December, it was certainly smaller, and toward the end, in turn, somewhat larger. The same held for the node of this comet. On 20 November it stood at 20° 48′ of Sagittarius; but then from day to day it moved on in the order of the signs, so that on 26 January it was found at ♐ 20° 54′. Tycho, by contrast, fixed that point of intersection as immovable at ♐ 20° 55′, which certainly ought in no way to have been done, since not even near the end of the apparition had it quite got that far. Indeed, not even his own calculation shows this; rather, if the greater part of the investigations is to decide, the node lay about the beginning of January at 20° 51′, and my calculation also agrees with this.

[Margin: Demonſtratur dictum angulum & Nodum variatos eſſe.] *It is demonstrated that the said angle and the node varied.*

You may indeed retort that Tycho nevertheless, in Chapter VI, page 97, where he brings the angle between the orbit and the ecliptic back to the anvil for each single day, established the said angle firmly at 29° 15′. But the answer is that scarcely a very few examples of the calculation there agree with one another at all: he finds the angle now 5 minutes smaller, now as many minutes larger, as is plain from Tycho's own calculation, which I have set out in this small table.

[Margin: Vnde Tycho in contrariam devenerit ſententiam.] *What led Tycho to the contrary opinion.*

According to Tycho.

Year 1577; month	Day	Angle between orbit and ecliptic
November	13	29° 20′
	14	29° 12′
	15	29° 14′
November	20	29° 15′
	21	29° 14′
	23	29° 14′
November	25	29° 15′
	29	29° 12′
	30	29° 20′
December	1	29° 15½′
	10	29° 12′
	12	29° 13′
December	13	29° 14′
	14	29° 14½′
	17	29° 13′
December	23	29° 18′
	30	29° 12′
	31	29° 12′
January	1	29° 14′
	2	29° 13½′
	5	29° 13′

Year 1577; month	Day	Angle between orbit and ecliptic
January	9	29° 13′
	12	29° 16′
	26	29° 18′

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This faltering of the calculation, however, is certainly not to be attributed to some unsteady observations, as Tycho indeed persuades himself. Rather, it plainly arose from the fact that in all the examples he always used the same first place of intersection, and one advanced too far in the order of the signs [in conſequentia], whereas he ought to have used a different one for each single day, by reason of the variation. Therefore, if at the beginning, namely on 13 November, he had assumed the node not at 20° 55′ but at ♐ 20° 48′, where it truly was at that time, then surely the angle of intersection with the ecliptic would not have come out as large as 29° 20′, but barely 29° 10′. Accordingly, since he erred on this point in every calculation, that examination is rightly rejected. But if one has a mind to examine the angle by this method, it is necessary, as we have often said, to presuppose the place of intersection corresponding to each single day; otherwise, surely, nothing certain is derived from it.

Tycho, however, is not to be reproached for having failed altogether to notice the anomaly of this angle. For since none of his predecessors had detected this inequality, let alone established it, he naturally presumed nothing of the kind, and so was easily deceived in this matter. There is, besides, the further point that the motion of this angle and of the node was very slow in that comet of 1577; and in such a case one errs far more readily than if the motion is fast. I do not doubt, therefore, that everyone will agree with me that the angle of inclination of the comet of 1577 increased continuously, and that its node advanced in the order of the signs, which is what we wished to show.

[Margin: Tycho excuſandus.] *Tycho is to be excused.*

But, you will say, granted that this really happened with the comet of the year 1577; yet Tycho, in a letter written to the most illustrious Prince of Hesse, on page 176 of his *Epistles*, indicates in clear words that matters stood quite otherwise with the comet of 1590, when he says: *Having compared with one another and carefully weighed the observations I obtained in the meantime, I find that this comet by its proper motion traced exactly the arc of a great circle, so that it deviated from it not at all, to this side or beyond, in the whole time it lasted. And this on the terms that, if that arc met the equator at 339° 45′ of it, it crossed it with an*

222 a small framed, ruled table, its caption "Juxta Tychonem." and head rows "Anno 1577" over "Menſis Dies", and "Angulus orb. / & Eclipt." over "Grad. Min.". The page prints it in two blocks side by side: the first, with caption and head, holds 13 November to 12 December; the second, without caption or head, holds 13 December to 26 January; they are given here as one table in the printed order. Each block is ruled into groups of three days, the month set once on the first row of each group.

inclination to it of 42° 0′, which was always alike, and remained entirely the same, etc. So he writes. From this it becomes plain that the angle of inclination and the node were stable; for whatever he states of the equator must also be understood of the ecliptic. Nevertheless I still hesitate over whether he examined everything properly himself: perhaps he was misled by one or another example of calculation obtained in a confused order. Therefore, since he did not add there the calculation itself of this angle and of the place of intersection, nor indicate from which observations those results were derived, I wished, for the sake of truth, to investigate it myself with due diligence, from the comet's given longitudes and latitudes for certain days. And so I found that the angle between the comet's orbit and the ecliptic was 21° 24′ on 26 February; that from that day it became gradually narrower up to 3 March, at which time it made a station [ſtationem fuisſe celebratam]; and that thereafter it became wider and wider again. The same happened with the node. At the beginning it stood at ♒ 21° 17′, yet it was carried with a very slow retrograde motion until 3 or 4 March, and afterwards became direct once more: just as

[Margin: Ex mente Tychonis Angulus inclinationis in Cometâ anni 1590 fuit ſtabilis.] *In Tycho's view the angle of inclination in the comet of 1590 was stable.*

[Margin: Autor demonſtrat Angulum inclinationis, Nodumq́; Cometæ 1590 variabilem extitisſe.] *The author demonstrates that the angle of inclination and the node of the comet of 1590 were variable.*

is plain from the accompanying small table, especially from the second, which shows for every day on which the comet shone the true daily motion both of the angle between the orbit and the ecliptic and of the place of intersection.

Angle of inclination to the ecliptic, and the node, of the comet of 1590, according to Hevelius's calculation.

Year 1590; month, day	Longi-tude	Latitude	Angle of orbit and ecliptic	Point of intersection
February 23	18° 27′ ♈	18° 14′ *B*		
			21° 24′	21° 17′ ♒
February 26	9° 11′ ♉	20° 55′ *B*		
February 23	18° 27′ ♈	18° 14′ *B*		
			21° 15′	20° 35′ ♒
March 1	21° 57′ ♉	21° 15′ *B*		
February 23	18° 27′ ♈	18° 14′ *B*		
			21° 13′	20° 25′ ♒
March 4	29° 44′ ♉	20° 58′ *B*		
February 23	18° 27′ ♈	18° 14′ *B*		
			21° 16′	20° 37′ ♒
March 6	3° 15′ ♊	20° 46′ *B*		

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Daily motion of the same angle and node, from the same calculation.

Year 1590; month, day	Angle of orbit and ecliptic	Point of intersection
February 26	21° 24′	21° 17′ ♒
27	21° 20′	20° 57′
28	21° 17′	20° 43′
March 1	21° 15′	20° 35′ ♒
2	21° 13′	20° 30′
3	21° 13′	20° 27′
March 4	21° 13′	20° 25′ ♒
5	21° 14′	20° 30′
6	21° 16′	20° 37′

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It is therefore sufficiently proven, from what has just been adduced, that in the comet of 1590 as well the angle of inclination was variable and the node movable.

Moreover, the most learned Willebrordus Snellius [Willebrord Snel], in his description of the comet, page 15, holds that the great and splendid comet of the year 1618 always described a great circle; which is plainly the same as if he had said that its angle of inclination was always of the same size. Peter Crüger too, a man of rare learning, agrees with him, in his *Uranodromus cometicus*, Chapter V, page 29, in these words: *Since, then, the calculation of this chapter testifies more than enough that the line, or arc of a circle, passing through the places of the comet on 8 and 29 December, likewise on 9 and 29, and on 8 and 15, always cut the equinoctial and the ecliptic in one and the same degree, it necessarily follows that all the places of the comet stood in one and the same great circle of the heavens; so that the comet's motion was in no way wandering and irregular, but that throughout the whole time it lasted it kept up the constant, regular motion of a circle, after the manner of the celestial bodies.*

[Margin: Quid Snellius & Crügerus de angulo inclinationis Cometæ 1618 ſenſerint.] *What Snel and Crüger thought about the angle of inclination of the comet of 1618.*

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223 the left-hand of two framed, ruled tables set side by side. Its head: "Anno 1590" over "Menſ. Dies"; "Longitudo." over "Gr.Mi. S."; "Latitudo." over "Gr.Min."; "Ang.orb. & Eclip." over "Gr Min."; "Punct.inter- ſectionis." over "Gr.Mi. S.". It is ruled into four groups, each pairing the observation of 23 February with one later observation; the angle and node of each group are printed once, centred on the half-line between its two dated rows, and are given here on a row of their own in the same place. The page sets "B" after every latitude, unexpanded.

224 the right-hand table, framed and ruled. Its head: "Anno 1590" over "Menſ. Dies"; "Ang.orb. & Eclip." over "Gr.Min"; "Punct inter- ſectionis" over "Gr.Min. S.". It is ruled into three groups of three days; the month and the sign of Aquarius are printed only on the first row of each group, the other rows carrying the day and the figures alone.

I reply, however, that on that very same page Crüger himself freely admits that the angle between the comet's orbit and the ecliptic does not agree entirely from one calculation to another, saying: *The second investigation, although the whole calculation of the longitude and latitude, and of what follows from them, was repeated twice, deviates from the rest by half a degree; yet in such a way that this deviation causes little hindrance in this matter, as is known to those skilled in these things.* He seems, therefore, to have ascribed the variation of this angle to the observations, not to an inequality. I, however, am firmly convinced that something calling for deeper inquiry lies hidden there; above all since the most sagacious Kepler holds the plain opposite about this comet in several places in his History. First, on page 72, in the small table placed there: *But through the remaining half of December and at the beginning of January the latitudes coincide exactly; but from 4 January up to the end of its duration there again appears a most manifest and quite notable deflection from the path of the great circle toward the south.* Second, on page 97, Question V: *Why do they for the most part seem to describe great circles? Answer: It is not absolutely tr-*

[Margin: Crügerus inæqualitatem hujus anguli animadvertens, eam obſervationibus adſcribit.] *Crüger, noticing the inequality of this angle, ascribes it to the observations.*

[Margin: Kepplerus, planè contrarius eſt Crügero] *Kepler is plainly contrary to Crüger.*

ue, as appeared in the comet of 1618, whose path was winding; but its path appears a great circle insofar as the motion of the earth, by reason either of its speed or of its position, is not perceived in them. Third, he adds in Question VI: *Comets, once they have become slow, begin to curve their paths, as the comets of the years 1607 and 1618 did, and many others.*

[Margin: Cometa anni 1618 circa finem inflexit iter à circuli ſui tramite.] *Toward the end, the comet of 1618 bent its path away from the path of its circle.*

Severinus Longomontanus likewise asserts of the same comet, in the Appendix to the *Astronomia Danica*, page 35, that the comet departed, that is, a very little from the path of its circle. In the same way J. Bapt. Cysatus [Johann Baptist Cysat], too, in his *Mathemat. Astron.*, page 21, Porism 5: *Although* (he says) *the comet, from the beginning of December up to 5 January, when it had its greatest latitude, or up to 3 January, when it was a quadrant of its circle away from the section with the ecliptic, described a great circle fairly exactly, with the same angle of intersection with the ecliptic, as was shown in Problem 5 and Porism 1, yet after 7 January it seems to have bent away somewhat from this exact path toward the south.* Likewise on the same page, near the end: *Therefore the exact course through these two positions did not reach as far as the comet, but tended further toward the north by perhaps one degree or more; and so the comet was bending away toward the south from its straight path.* Finally, other very learned men have also noticed this very thing, as can be seen from Book III of the *Meteorologica* of Libertus Fromondus [Libert Froidmont], page 219: *I would have finished* (he says) *had this clause too not come to mind: why does the proper motion of certain comets twist itself at the end*

like a snail's shell, and bend away for a little from the segment of a great circle? For Cysat noted this, and so did our Godefridus Wendelinus [Govaert Wendelen], a man most worthy of a greater fortune, in the comet of the year 1618.

[Margin: Idem teſtatur Longomontanus.] *Longomontanus attests the same.*

[Margin: J. Bapt.Cyſatus.] *Johann Baptist Cysat.*

[Margin: Libertus Fromondus.] *Libert Froidmont.*

From this it is indeed clear that Kepler, Longomontanus, Cysat and Wendelen differ in this matter from Snel and Crüger by the whole heaven; but however that may be, I scarcely think that everyone will be satisfied by this argument drawn from authority. Therefore we ourselves computed in order, with the greatest care, this angle of intersection with the ecliptic, and its node, from Crüger's observations. We found that on 9 December the said angle was 64° 43′, but that with the passage of time it decreased continuously, so that on 29 December it was found to be only 63° 19′. The same happened with the place of intersection: from 9 December to the 29th of that month it advanced with a continuous motion in the order of the signs. But so that the decrease of the motion can be more easily understood and seen with the eyes, I have constructed two small tables of it, the second of which shows the anomaly both of the angle and of the node for every single day of the whole duration.

[Margin: Autorum diſſenſio.] *Disagreement of the authors.*

[Margin: Autor commonſtrat & hujus Cometæ 1618 angulum inclinationis, Nodumq́; variationi obnoxium fuiſſe.] *The author shows that in this comet of 1618 too the angle of inclination and the node were subject to variation.*

The observation made on 8 December does seem to waver somewhat; but this is to be ascribed to nothing other than that doubtful observation. For if the whole matter is weighed on an accurate balance, we find that a like motion truly occurred both in the angle of intersection and in the node.

From these well-founded demonstrations it is now sufficiently proven (Tycho, Snel and Crüger notwithstanding) that in those three comets, namely of the years 1577, 1590 and 1618, the angle of inclination was always varying and the node movable.

Angle of inclination to the ecliptic, and the node, of the comet of 1618, from Crüger's observations and Hevelius's calculation.

Year 1618; month, day	Longitude	Latitude	Angle of orbit and ecliptic	Node
December 8	28° 35′ 40″ ♎	29° 8′ 25″ *B*		
			64° 43′	13° 52′ ♏
December 9	26° 46′ 0″ ♎	31° 51′ 0″ *B*		
December 8	28° 35′ 40″ ♎	29° 8′ 25″ *B*		
			64° 1′	14° 22′ ♏
December 15	12° 57′ 0″ ♎	46° 55′ 0″ *B*		
December 8	28° 35′ 40″ ♎	29° 8′ 25″ *B*		
			64° 15′	14° 12′ ♏
December 20	1° 28′ 0″ ♎	54° 36′ 0″ *B*		
December 8	28° 35′ 40″ ♎	29° 8′ 25″ *B*		

Year 1618; month, day	Longitude	Latitude	Angle of orbit and ecliptic	Node
			63° 19′	14° 52′ ♏
December 29	6° 53′ 48″ ♍	61° 32′ 0″ *B*		

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Daily and continuous motion of the same angle and node.

Year 1618; month, day	Angle of orbit and ecliptic	Node
December 9	64° 43′	13° 52′ ♏
10	64° 33′	13° 58′
11	64° 24′	14° 4′
December 12	64° 16′	14° 9′ ♏
13	64° 10′	14° 14′
14	64° 5′	14° 18′
December 15	64° 1′	14° 22′ ♏
16	63° 56′	14° 26′
17	63° 51′	14° 30′
December 18	63° 47′	14° 33′ ♏
19	63° 43′	14° 36′
20	63° 39′	14° 39′
December 21	63° 35′	14° 41′ ♏
22	63° 32′	14° 43′
23	63° 29′	14° 45′
December 24	63° 26′	14° 46′ ♏
25	63° 24′	14° 48′
26	63° 22′	14° 49′
December 27	63° 21′	14° 50′ ♏
28	63° 20′	14° 51′
29	63° 19′	14° 52′

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But so that the matter may be clearer still, I would have you know that Christophorus Rothmannus [Christoph Rothmann], a man otherwise of singular learning, likewise noticed with complete certainty in the comet of the year 1585 that the same angle of intersection decreased from the comet's first rising

[225] the left-hand of two framed, ruled tables set side by side at the head of the page. Its head: "Anno 1618" over "Menſ. Dies"; "Longitudo." over "Gr.Mi.Sec. S."; "Latitudo." over "Gr.Min.Sec."; "Ang.orb. & Eclip." over "Gr.Min."; "Nodus." over "Gr.Mi. S.". It is ruled into four groups, each pairing the observation of 8 December with one later observation; the angle and node of each group are printed once, centred on the half-line between its two dated rows, and are given here on a row of their own in the same place. The page sets "B" after every latitude, unexpanded. In the 20 December row a raised point stands between the seconds and the sign.

[226] the right-hand table, framed and ruled. Its head: "Anno 1618" over "Menſ. Dies"; "Ang orb. & Eclip." over "Gr.Min."; "Nodus" over "Gr.Min. S.". It is ruled into seven groups of three days; the month and the sign of Scorpio are printed only on the first row of each group, the other rows carrying the day and the figures alone.

up to its extinction. For he says in Chapter II, page 85, of his description of the comet: *It is therefore manifest that the angle of intersection of the comet's circle and the ecliptic decreased, by 26 minutes in the first interval, but by 1 degree in the other.* Tycho himself also attests the same about the same heavenly body, in Book I of his *Epistolae Astronomicae*, page 15, in these words: *But if this motion is weighed geometrically by means of triangles, it will appear that by its own proper course it described an arc of a circle that was truly a great circle, which nevertheless admitted, successively, a somewhat variable inclination to the equator and the ecliptic, and which crossed the equator at 14° 55′ from the vernal intersection, and the ecliptic at ♈ 27° 38′. The change (of which I spoke) went by this law: around the midnight following the noon of the 18th, the angle of declination to the equator was about 45½ degrees, and to the ecliptic 27° 17′, and it diminished step by step, so that on 14 November it was 44° 50′ to the equator. The inclination to the ecliptic was 22° 21′; and at the end of the apparition, on the 12th, the same was found to be 44° 19′ with respect to the equator, but 21° 34′ with respect to the ecliptic. And in this way, in the intermediate spaces too, the obliquity of the portion of the comet's circle to the equator and the ecliptic decreased little by little, by a regular diminution.* This is evident more clearly still from his own small table on page 19 of the *Epistolae*. And so the variation of the angle to the equator grew to 1° 18′, and that to the ecliptic to 1° 52′, over the whole time of the apparition. Likewise the motion of the comet's orbit and the ecliptic also advanced in the order of the signs [in consequentia], though very slowly: over the whole time of its duration, scarcely about 20 minutes. I have been glad to add here as well its motion and its place in the ecliptic, worked out by my own effort. It was investigated by the method we use elsewhere, taking as the foundation, namely, the observation made by Tycho on 19 October, when the comet stood at 21° 45′ of longitude and 2° 30′ of southern latitude.

[Margin: Rothmannus idem inCometâ 1585 deprehendit.] *Rothmann found the same in the comet of 1585.*

[Margin: Etiam ab ipſo Tychone motus inclinationis orbitæ inCometâ anni 1585 animadverſus eſt.] *Tycho himself, too, noticed the motion of the inclination of the orbit in the comet of 1585.*

[Margin: Motus orbitæ & Eclipticæ Cometæ anni 1585 directus fuit.] *The motion of the orbit and the ecliptic of the comet of 1585 was direct.*

Table of the motion of the inclination of the comet's orbit, to the equator as well as to the ecliptic, and of the point of intersection with the ecliptic, for the comet of 1585.

Year 1585; month, day	Inclination to the equator, from Tycho's work	Inclination to the ecliptic, from Tycho's work	Northern node of the comet, from Hevelius's work
October 18	45° 28′	23° 17′	27° 39′ ♈
19	45° 26′	23° 7′	27° 39′
20	45° 23′	22° 57′	27° 39′
October 21	45° 21′	22° 54′	27° 39′ ♈
22	45° 18′	22° 52′	27° 40′
23	45° 16′	22° 50′	27° 40′

Year 1585; month, day	Inclination to the equator, from Tycho's work	Inclination to the ecliptic, from Tycho's work	Northern node of the comet, from Hevelius's work
October 24	45° 14′	22° 47′	27° 40′ ♈
25	45° 12′	22° 45′	27° 41′
26	45° 10′	22° 43′	27° 41′
October 27	45° 8′	22° 40′	27° 41′ ♈
28	45° 6′	22° 38′	27° 42′
29	45° 4′	22° 36′	27° 42′
October 30	45° 2′	22° 34′	27° 43′ ♈
31	45° 0′	22° 31′	27° 44′
November 1	44° 58′	22° 29′	27° 45′
November 2	44° 55′	22° 27′	27° 46′ ♈
3	44° 53′	22° 25′	27° 47′
4	44° 50′	22° 21′	27° 48′
November 5	44° 46′	22° 16′	27° 49′ ♈
6	44° 41′	22° 8′	27° 50′
7	44° 36′	22° 0′	27° 51′
November 8	44° 31′	21° 53′	27° 52′ ♈
9	44° 26′	21° 45′	27° 53′
10	44° 22′	21° 41′	27° 54′
November 11	44° 19′	21° 37′	27° 55′ ♈
12	44° 16′	21° 34′	27° 56′
13	44° 13′	21° 31′	27° 57′
November 14	44° 12′	21° 28′	27° 59′ ♈
15	44° 10′	21° 25′	28° 1′

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And so this too is very true: that the angle of inclination of this comet was likewise subject to change, but to a supremely regular one.

Lastly, in the comet of the year 1607, as Kepler attests in his History of Comets, page 97, the angle so often mentioned changed in roughly the same way. Longomontanus too agrees with this, on page 29 of *De novis Cœli phænomenis*, when he says: *But it is to be noted that the said comet crossed the equator on 29 September, a little after 236 degrees; and indeed it was detected to have first evidently deviated from the path of a great circle on 1 October, when it had almost reached the stars in the left hand of Ophiuchus.* Hence, therefore, I think it sufficiently clear that the matter was not otherwise, although I could not examine these things myself by calculation, for lack of sufficient observations.

227a framed, ruled table. Its head: "Anno 1585" over "Menſ. Dies"; "Inclinat. ad Æqu. operâ Tychonis." over "Grad. Min."; "Inclinat. ad Eclipt.operâ Tychonis." over "Grad. Min."; "NodusCom. Bor. operâ Hevelii." over "Gr.Min. S.". It is ruled into ten groups, nine of three days and the last of two; the month is printed on the first row of each group and again where November begins inside a group, the last two groups setting "Nov."; the sign of Aries is printed only on the first row of each group. The node column passes from 27° 57′ on 13 November to 27° 59′ on 14 November, as printed.

[Margin: Idem motus etiam in Cometâ anni 1607 obſervatus eſt.] *The same motion was observed in the comet of 1607 as well.*

Yet before we leave this subject, let us try to confirm this matter by some observations of the older astronomers as well: namely by the three comets observed by that most diligent man Petrus Appianus [Peter Apian] in the years 1531, 1532 and 1533, and accurately described in his most ample *Mathematicum Cæsareum* [Mathematico Cæſareo]. Having therefore got through a laborious calculation, which it would be too tedious to add here, we have found more than enough that in all three both the angle of the comets' path and their node were driven by a definite motion, but in each comet by a peculiar and quite different one. In the earlier comet, that of the year 1531, the angle between the comet's path and the ecliptic was 23° 17′ around its first sighting, but it gradually increased up to its disappearance. Its node, however, was carried against the sequence of the signs, and indeed with a fairly swift motion, which we have scarcely noticed in other comets so far. In the one observed in 1532, by contrast, the inclination to the ecliptic increased at first; then, after a stationary period, it decreased in turn at the end, while the node meanwhile tended continuously in the order of the signs. But in the later comet, which shone in the year 1533, the said angle decreased throughout the whole time of its duration, while the node, like that of the preceding comet, likewise advanced according to the order of the signs; as is clearly seen from the accompanying small table. The first column, the month and the day on which

[Margin: Antiquiorum quibusdam exemplis idem probatur.] *The same is proved by some older examples.*

[Margin: Motus inclinationis Orbitæ & Nodorum Cometæ 1531.] *Motion of the inclination of the orbit and of the nodes of the comet of 1531.*

[Margin: Cometæ anni 1532.] *Of the comet of 1532.*

[Margin: Cometæ anni 1533.] *Of the comet of 1533.*

the comet was observed, the second the longitude, the third the latitude, the fourth the angle of the orbit and the ecliptic, the fifth the place of intersection with the ecliptic, while the sixth shows its own proper motion in the circle of its path.

Ephemeris of the three comets observed by Peter Apian, constructed by Johannes Hevelius.

Comet	Month, day	Longi-tude	Latitude	Angle of orbit and ecliptic	Place of intersection	Proper motion
1531	August 14	23° 39′ ♌	23° 2′ *S.*			
	15	24° 29′ ♌	22° 0′ *S.*			
	16	4° 32′ ♍	22° 1′ *S.*	23° 17′	14° 46′ ♏	10° 6′
	August 17	9° 14′ ♍	21° 25′ *S.*	23° 21′	13° 38′ ♏	4° 25′
	18	15° 30′ ♍	20° 12′ *S.*	23° 23′	13° 9′ ♏	5° 59′
	22	1° 23′ ♎	16° 32′ *S.*	23° 39′	9° 47′ ♏	11° 50′

Comet	Month, day	Longitude	Latitude	Angle of orbit and ecliptic	Place of intersection	Proper motion
	23	2° 51′ ♎	34° 31′ *S.*	23° 43′	9° 8′ ♏	5° 37′
1532	October 2	8° 24′ ♍	13° 44′ *A.*			
	3	11° 25′ ♍	10° 12′ *A.*			
	19	5° 46′ ♎	4° 51′ *S.*	35° 2′	28° 48′ ♍	32° 55′
	October 31	21° 30′ ♎	13° 15′ *S.*	33° 9′	0° 23′ ♎	17° 35′
	November 1	23° 57′ ♎	14° 42′ *S.*	31° 47′	1° 38′ ♎	2° 4′
	8	3° 35′ ♏	19° 36′ *S.*	32° 20′	3° 13′ ♎	10° 12′
1533	June 18	3° 40′ ♊	32° 0′ *S.*			
	21	29° 20′ ♉	36° 20′ *S.*	62° 34′	22° 35′ ♊	6° 26′
	23	21° 30′ ♉	40° 30′ *S.*	52° 43′	2° 4′ ♋	6° 32′
	25	15° 0′ ♉	43° 0′ *S.*	51° 0′	4° 4′ ♋	5° 25′

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And so, I think, this motion of the inclination of the orbit and of the node is established again and again, and sufficiently. For my part, to confirm the matter further, I had resolved to bring forward still more examples of comets, if suitable and accurate observations, of the kind that the elucidation of this matter uniquely demands, had been at hand. But among the older astronomers such observations are found not at all, and among the more recent scarcely a very few. The greatest part of the astronomers takes delight rather in vain and ambiguous predictions, and strives to please the common people, than to search thoroughly into such very subtle phenomena of the heavens. Yet it matters indeed not a little to all philosophers to know these things rightly: first, namely, whether such a phenomenon really occurs only in certain comets, or in all of them; second, what the genuine cause of this appearance is; and third, to say nothing of the rest, whether this phenomenon is a certain sign of some notable parallax. The most distinguished Johann Baptist Cysat agrees with me, on page 21 of his description of the comet of the year 1618: *The comet was deflected toward the south from its straight path. This bending would indeed be a phenomenon of great moment, if it were confirmed by more observations. We do not wish to decide from our one comet. It may be that the stars on the globe were not placed accurately enough, through the carelessness of the one who drew them on, or*

[228] a framed, ruled table. Its head: "Cometa."; "Menſ. Dies"; "Longitudo." over "Gr.Min. S."; "Latitudo." over "Gr. Min."; "Angulus or- bit.& Eclip." over "Grad. Min."; "Locus inter- ſectionis." over "Gr. Mi, S."; "Motus pro- prius." over "Grad. Min.". Double rules divide the three comets, and a single rule divides each comet's rows into two groups (1531: 14–16 and 17–23 August; 1532: 2–19 October and 31 October–8 November; 1533: 18–21 and 23–25 June). In each first group the last three columns are blank on the earlier rows, and a single value is printed on the group's last row, with a brace in the angle column joining that row to the rows above it. The page sets "S." or "A." after every latitude, unexpanded. The latitude for 23 August 1531 is printed 34° 31′, after 16° 32′ on 22 August.

that the observation of the comet's position in one straight line with two fixed stars (however accurately it is made) is not so infallible. We therefore leave this porism undecided. From this one can see that the same author already at that time had some inkling of the motion of the inclination of the cometary orbit; but since he had not yet become sufficiently certain of the matter, he was afraid, as is fitting, to lay down anything certain.

[Margin: Pleriq; Aſtronomorum vanis oblectantur prædictionibus.] *Most astronomers delight in vain predictions.*

We do not overstep the limits, however, if we declare and finally conclude, both from our own comet of the year 1652 and from all the others adduced above (whose observations were drawn from the most trustworthy writers and worked out by our own effort), that the angle of inclination of the comet's orbit, to the equator as well as to the ecliptic, and also the nodes of the comet, are variable and movable. I add that later generations will certainly notice that such a thing has happened not only in the comets mentioned but also in all subsequent ones, if any appear, provided that these phenomena are observed by them with larger and suitable instruments. We wish all mathematicians, each and every one, to be asked again and again to apply themselves diligently to this study in their own time.

Finally, it should be well noted here that this angle and the node vary neither in all comets nor at all times in one and the same way. For sometimes the angle of inclination widens from the beginning to the end in a certain proportion, and the node is carried against the order of the signs [in antecedentia], the longitude being direct and the latitude always northern: witness the comet of the year 1531, observed by Apian. Sometimes the angle itself narrows around the first appearance, becomes stationary around the middle, and widens again around the last, the node and the longitude being direct throughout, and only the latitude diverse [diversâ]; as appeared in the comet of the year 1532. Sometimes the angle decreases throughout, the node meanwhile tending in the direct sense, the longitude being retrograde and the latitude increasing: as was found in the comet of the year 1533. Sometimes, over the whole duration, the angle of inclination is compressed more and more, the node indeed being direct, but the longitude retrograde, and the latitude increasing toward the north. Sometimes the angle increases continually, the node meanwhile advancing step by step in the order of the signs, as is clear enough from the comet of the year 1577, whose longitude was always direct and whose latitude was increasing the whole time. Sometimes the angle of inclination decreases continually, the longitude being direct but the latitude diverse, as was observed in the comet of the year 1585. Sometimes this angle is found decreasing from the beginning of the apparition, stationary in the middle, and increasing again at the end, as the comet of the year 1590 clearly attests, although the motion of its longitude and latitude, over the whole time of its duration, agrees entirely with the preceding comet. Sometimes the angle of inclination increases throughout, the motion of the node being reciprocal, the longitude direct, and the latitude entirely diverse:

as is clearly evident from the comet of the year 1607. Sometimes the angle diminishes from around the comet's first rising up to its station, and afterwards increases again, the node being at first direct, then stationary, and lastly direct; while the longitude was continually retrograde, and the latitude increasing at the first appearance, then stationary, and finally decreasing: as happened with the comet of the year 1618. Sometimes the angle increases little by little over the whole time of the duration, the node meanwhile advancing according to the sequence of the signs, although the longitude is retrograde at the beginning and direct at the end, while the latitude is continually increasing: witness our own comet of the year 1652. But so that this variation in the comets mentioned above may be perceived still more clearly by everyone, I have been pleased to add the following small table. Its first column indicates in what

[Margin: Omnium Cometarum inclinatio orbitæ variabilis, & Nodi mobiles ſunt.] *The inclination of the orbit of all comets is variable, and their nodes are movable.*

[Margin: Sed in quolibet diverſâ ratione.] *But in each in a different way.*

[Margin: Comprobatur exemplis.] *It is proved by examples.*

[Margin: Cometâ anni 1531.] *By the comet of 1531.*

[Margin: Cometâ 1532.] *By the comet of 1532.*

[Margin: Cometâ 1533.] *By the comet of 1533.*

[Margin: Cometâ 1577.] *By the comet of 1577.*

[Margin: Cometâ 1585.] *By the comet of 1585.*

[Margin: Cometâ 1590.] *By the comet of 1590.*

[Margin: Cometâ 1607.] *By the comet of 1607.*

[Margin: Cometâ 1618.] *By the comet of 1618.*

[Margin: Cometâ 1652.] *By the comet of 1652.*

year the comet was observed; the next divides the time of the apparition into beginning, middle and end; the third sets out the angle of inclination; the fourth, the node; the fifth, the longitude; the sixth, the latitude; and the last supplies the comet's motion in its own orbit at those different times.

Variation of the angle of inclination, of the node, of the longitudes, of the latitudes, and of the motion in the circle of its path, of nine comets.

Comet of the year	Time of the apparition	Angle of inclination	Node, or place of intersection	Longitude	Latitude	Motion of the comet in its path
1531	Around the beginning	Increasing	Retrograde	Direct	Decreasing *B.*	Fairly fast
	middle	Increasing	Retrograde	Direct	Decreasing *B.*	Faster
	end	Increasing	Retrograde	Direct	Decreasing *B.*	Slacker
1532	Around the beginning	Decreasing	Direct	Direct	Decreasing *A.*	Fairly slow

Comet of the year	Time of the apparition	Angle of inclination	Node, or place of intersection	Longitude	Latitude	Motion of the comet in its path
	middle	Stationary	Direct	Direct	Increasing *B.*	Faster
	end	Increasing	Direct	Direct	Increasing *B.*	Slacker
1533	Around the beginning	Decreasing	Direct	Retrograde	Increasing *B.*	Fairly slow
	middle	Decreasing	Direct	Retrograde	Increasing *B.*	A little faster
	end	Decreasing	Direct	Retrograde	Increasing *B.*	Faster
1577	Around the beginning	Increasing	Direct	Direct	Increasing *B.*	Fairly slow
	middle	Increasing	Direct	Direct	Increasing *B.*	Stationary
	end	Increasing	Direct	Direct	Increasing *B.*	Slow
1585	Around the beginning	Decreasing	Direct	Direct	Decreasing *A.*	*Med.* fast
	middle	Decreasing	Direct	Direct	Increasing *B.*	Slacker
	end	Decreasing	Direct	Direct	Increasing *B.*	Slow
1590	Around the beginning	Decreasing	Retrograde	Direct	Decreasing *B.*	Very fast
	middle	Stationary	Stationary	Direct	Stationary *B.*	Slacker
	end	Increasing	Direct	Direct	Increasing *B.*	Slow
1607	Around the beginning	Increasing	Direct	Direct	Increasing *B.*	Very fast
	middle	Increasing	Stationary	Direct	Stationary *B.*	Slacker
	end	Increasing	Retrograde	Direct	Decreasing *B.*	Very slow

Comet of the year	Time of the apparition	Angle of inclination	Node, or place of intersection	Longitude	Latitude	Motion of the comet in its path
1618	Around the beginning	Decreasing	Direct	Retrograde	Increasing *B.*	Fast
	middle	Stationary	Stationary	Retrograde	Stationary *B.*	Slacker
	end	Increasing	Retrograde	Retrograde	Decreasing *B.*	Very slow
1652	Around the beginning	Increasing	Direct	Retrograde	Decreasing *A.*	Very fast
	middle	Increasing	Direct	Retrograde	Increasing *B.*	Slacker
	end	Increasing	Direct	Stationary and direct	Increasing *B.*	Very slow

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I therefore think it rightly said that the inclination of the angle, to the equator as well as to the ecliptic, and the node of the comets undergo their own variations and vicissitudes, yet bounded by the utmost and by a certain regularity, or rather by a regular inequality (which I would have you note well); so that each and every comet moves in an entirely peculiar way, after the manner of the planets, and very rarely does one correspond to another altogether in every respect. This is what we wished to demonstrate, as it were, to the eye.

[Margin: Cometæ more Planetarum, moventur, ratione anguli inclinationis &Nodorum.] *Comets move after the manner of the planets with respect to the angle of inclination and the nodes.*

Section XI. To Investigate the Time at Which a Comet Crossed the Equator and the Ecliptic [SECTIO XI. Tempus,quo Cometa Æquatorem,Eclipticamq́; trajecerit, indagare.]

Before we go in search of that very thing, let us resolve this question: whether, namely, each and every past comet has crossed the equator and the ecliptic, and whether future ones too must necessarily cross those circles. It should be known, then, to be brief, that since no comet has ever, as far as is clear from

229a framed, ruled table of seven columns. Its head: "Cometa / anni"; "Tempore appa- / ritionis."; "Angulus incli- / nationis."; "Nodus ſ.Locus / interſect."; "Longitudo."; "Latitudo."; "Motus Cometæ / in ſuo tramite.". Nine blocks of three rows, one for each comet, divided by rules; the year is printed once per block, and "Circa" once per block, before "Initium", with "Medium" and "Finem" alone on the rows below. The page sets "B." or "A." after every latitude word, unexpanded, and "Med." in the 1585 motion cell, unexpanded. The table prints no figures beyond the years.

their history, been entirely without all declination and latitude, but has been now northern, now southern, it is readily gathered that no comet has ever arisen that did not at a certain time intersect the said circles. This holds, however, on this express condition: unless the comet was extinguished by diminution, or wholly absorbed by the rays of the Sun, before it could reach that point by its proper motion in its own path. And finally, unless one of the comets travelled above or below the obliquity of the ecliptic, at 24 degrees and more, from west to east, that is, or conversely from east to west, namely in the northern or the southern part of the heavens, around the tropics.

Then, too, we can scarcely persuade ourselves that it could easily happen (although it is not altogether absurd either) that some comet should perpetually take the ecliptic or the equator as its path so strictly that it would not deviate in some way toward this region or that. Even supposing that some comet were found in future that adhered exactly to the ecliptic at all times, it could still in no way avoid the equator in the course of time. For just as the ecliptic intersects the equator at a certain angle, so such a comet will surely intersect that circle. The exception is those comets that are carried under the poles on a course roughly parallel to the equator or the ecliptic.

In the same way, if a comet travelled in the equator, it would in turn cross the ecliptic. Hence we conclude quite rightly that every comet tending from south to north, or from north to south, reaches either both great circles, or at least one of the two, provided that it remains visible long enough (which I would have you note well).

Meanwhile, however, you should know that very many comets have shone whose line of travel never cut either the equator or the ecliptic. This, as we said just now, arises from nothing other than that they did not remain in our sight long enough to reach those circles by their own proper motion. Of this kind was the comet observed by Apian in the year 1531: because it was carried above the ecliptic toward the north, from west to east, and in the more northern signs, over a space of only a few days, it is certainly established that it did not reach the equator and the ecliptic. To that number must also be counted the comet of the year 1533, noticed by the same observer: since it was of still shorter duration, and travelled both nearer the North Pole and from east toward west, it therefore touched the said circles all the less, let alone crossed them. To this also belongs the comet of the year 1590, accurately noted by Tycho,

[Margin: An omnes & ſinguliCometæ, ex certâ lege Æquatorem Eclipticamq́; trajiciant ?] *Whether each and every comet crosses the equator and the ecliptic by a fixed law?*

[Margin: Multi Cometarum necÆquatorem nec Eclipticam transgrediuntur.] *Many comets cross neither the equator nor the ecliptic.*

whose latitude and declination too were found to be northern over the whole time of its duration, and which therefore by no means reached the intersection of those circles. All the remaining comets, however, namely those of the nine

mentioned in the preceding Section, that is, the comets of the years 1532, 1577, 1585, 1607, 1618 and 1652, crossed the ecliptic and the equator.

From this, then, it is quite clear enough that some comets have crossed, or will cross, the said circles, while others have not lasted, and will not last in future, long enough to be able to reach them. Some, too, travel beneath the poles on such a path that they can by no means reach the said circles. This could also easily have been shown by more examples, had accurate observations not been lacking; we must therefore rest content with these. Now, however, it is time to come to our own comet and to inquire at what time, namely, it crossed both the equator and the ecliptic, above all since it has been more than sufficiently demonstrated in what place, and in what manner, that crossing took place.

As for the equator, it is gathered without any effort that the comet did cross it between December 20 and 23; but the question is on precisely what day and at what hour this happened. That, however, is accomplished without great trouble: namely, by resolving only one triangle and finding one side, in the diagram [Schematismo] added in Section IX, page 87, and shown here again for that purpose.

In it, AB represents the equator, DC the line of the comet's path, M the comet's first appearance, made by us on December 20 at 7 in the evening, and ML its declination at that very time, 8° 41′ 14″ south. Let there be sought, then, in the triangle HLM, right-angled at L, MH, that is, the proper motion in its path up to the equator itself, given, namely, the declination LM and the side HL, which side was already found in Section IX, page 88, Calculation 1, to be 4° 27′ 45″. When, therefore, the antilogarithms of those two sides, LM and HL, are added, the result is the antilogarithm of the hypotenuse, that is, of the interval sought in the proper orbit, namely between the first observation and the equator. For example:

Diagram. An engraved figure in a ruled rectangle beside the text: a circle crossed by the straight line BA, the equator, and by the straight line DC, the comet's orbit, which crosses BA at H. From E at the top of the circle three lines descend: a curved circle of declination through O and across BA at L, down to M on DC, a straight line to I on BA, and a curved circle of declination through F to K on BA. Dotted lines join N to F and O to G; G stands where DC meets the line from E to I. M stands on DC above D. Engraver's signature at the lower right: "Autor Sculps." (the author engraved it). Every printed label is listed; none is unread.

- E (top of the circle): point
- C (upper right, on the circle): point; end of the orbit line
- "Circ. Declinat." (along the curve from E through O and L): circle of declination
- "Declin:" and "Circul." (along the curve from E through F to K, above and below F): circle of declination
- "Cometæ." (along DC, above F): of the comet

- "Orbita" (along DC, near D): orbit
- N, F, O, G (inside the circle): points; N–F and O–G joined by dotted lines
- B (left end of the equator), A (right end): points
- L, H, I, K (on the equator line BA): points
- "Æquator." (beside K, below BA): equator
- M (on DC, at the foot of the line through L): the comet's first appearance, per the text
- D (lower left, on the circle): point; end of the orbit line
- "Autor Sculps." (lower right, inside the frame): the author engraved it

Antilogarithm ML 1154
Antilog. HL 304 *Add.*
Antilog. HM 1454 — 9° 45′ 36″[230]

This many degrees and minutes, then, the phenomenon must clearly have completed from December 20 at 7 in the evening up to the equator. Now if one inquires in what interval of time the comet travelled so great a stretch of its path by reason of its proper motion, it becomes known at the same time when it crossed the equator. This, however, is done most easily from the Table of the comet's proper motion set out in days and hours, inserted in the preceding Section, page 110. In that Table, since the comet's proper motion, from December 20

[Margin: Quò tempore Cometa anni 1652 Eclipticam transiverit.] *At what time the comet of the year 1652 crossed the ecliptic.*

at 7 in the evening likewise takes its beginning, one need only investigate in it on what day and at what hour the comet completed 9° 45′ 36″ according to that continuous and correctly proportioned motion. In this way it will become clear that this happened on December 21 between 3 and 4 o'clock in the afternoon; and when the due proportional part is applied, the true crossing of the equator took place at $3^{h}\ 13^{m}\ 47^{s}$ p.m. This could also be established by a great many other examples, but we consider that superfluous. Let us therefore turn to investigating the crossing of the ecliptic.

This investigation is undertaken in an entirely similar way, except that in this matter we need a different figure: the one by which the angle of the orbit and the ecliptic was found at that time, placed in Section X, page 93, and repeated here for the sake of better understanding. In it AB denotes the ecliptic, DC the course of the comet's path, F the comet's place at its first appearance, on December 20 at 7 in the evening, and FH the interval which the comet had to traverse up to the ecliptic, and which we have now set ourselves to investigate in the right-angled triangle HKF.

Diagram. An engraved figure in a ruled rectangle beside the text: a circle crossed by the straight line BA, the ecliptic, and by the straight line DC, the

[230] a worked calculation, set as printed: a rule stands under the figure 304 and above 1454. The printed sum, 1454, is not the sum of the two figures printed above it, 1154 and 304, which make 1458; the page's figures stand.

comet's orbit, which crosses BA at H; along the circle's edge is written "Colurus … Solftitiorum." (the solstitial colure). From E at the bottom of the circle two circles of latitude rise, one through F crossing BA at K, the other through N crossing BA at I; F and N are joined by a dotted line. From E at the top of the circle a third circle of latitude runs down through the upper G, where it meets DC, to L on BA. A second G stands below BA beside the line through I. Engraver's signature at the lower right: "Autor Sculps." (the author engraved it). The letters E and G are each printed twice. Every printed label is listed; none is unread.

- "Colurus" (upper left, along the edge) and "Solftitiorum." (right, along the edge): the solstitial colure
- E (top edge) and E (bottom edge): points, each printed once
- "Circ. Latit." (upper, along the line from the top E): circle of latitude
- C (upper right, on the circle): point; end of the orbit line
- "Cometæ." (along DC, toward C): of the comet
- G (upper, where DC meets the upper circle of latitude) and G (lower, below BA beside the line through I): points
- B (left end of the ecliptic), A (right end): points
- K, I, H, L (on BA): points
- "Ecliptica" (along BA, toward A): ecliptic
- F (on DC, below BA): the comet's place at its first appearance, per the text
- N (to the right of F, on the line through I): point; joined to F by a dotted line
- D (lower left, on the circle): point; end of the orbit line
- "Orbita" (along DC, near D): orbit
- "Circ. Latit." (below F) and "Circ. Latitud." (below N): circles of latitude
- "Autor Sculps." (lower right, inside the frame): the author engraved it

In it, moreover, FK, the comet's latitude, is given, and likewise the side HK. For HI was already known from the first calculation of the angle of inclination to the ecliptic, page 95, in the preceding Section X, namely 29′ and 44″; and likewise, in the same place, IK, that is, the difference of longitudes, 9° 22′ 43″. If, then, these sides HI and IK are put into one sum, they produce that side HK, 9° 52′ 27″. When, therefore, the antilogarithms of KF and HK are added as above, there results the antilogarithm HF of the interval between the first observation and the ecliptic, in this way:

Latitude of the comet KF 30° 49′ 1″ Antilog. 15221
Side HK 9 52 27 Antilog. 1492 *Add.*
Antilog. HF 16713 32° 12′ 40″ HF.[231]

So great a stretch remained for the comet, from December 20 at 7 in the evening, up to the ecliptic itself. Now if that very interval of its path is sought accurately in the same said table of continuous proper motion, you will find

[231] a worked calculation, set as printed: the side HK is printed "9 52 27" without degree, minute or second marks; a rule stands under 1492 and above 16713.

that the crossing of the ecliptic took place on December 24 in the morning, at 5^h 21^m [?] 11^s; and this too had to be examined.

And now that both have been found in this way, the interval which the phenomenon had to traverse from the first observation, made on December 20 at 7 in the evening, up to the equator, and the stretch which it had to traverse from the said observation up to the ecliptic, and also the true time at which the comet crossed those circles, it remains for us now to construct a Table of the true motion of the comet from the intersection both of the equator and of the ecliptic. Likewise, for the sake of those who are taken with a deeper investigation of celestial things, let us now at the same time set out for all, in one view, the most diverse motions of this star, for the individual days of the whole apparition and their quarters, which we have hitherto sought so scrupulously, both in longitude, latitude, right ascension and declination, and in proper motion along its path; and so, as a supplement [mantiſſæ loco], let us add an accurate ephemeris of these motions, concluding with it this Section XI of Book I.

[Margin: Quâ ratione ſubſequens Ephemeris fuerit conſtructa.] *How the following ephemeris was constructed.*

We first investigated the latitude and longitude, and then the declination and right ascension, not only for any day of the whole duration but also for the quarters of days, so as to know all the better and more accurately the increase and decrease of our comet's motion. But we did so by an entirely peculiar method, one we have not used before. Given, namely, the angle of the orbit and the ecliptic at H, the proper motion, that is, the distance from the intersection, FH or HG, and the point of intersection H, we examined the latitude KF or LG by resolving only the one right-angled triangle HKF, with the help of the preceding figure, when the latitude is southern, or HLG when the latitude is northern. That is, when the logarithms of the said angle and of the distance from the intersection are added, there results KF or LG, the logarithm of the latitude. The longitude, however, becomes known in the same triangle: when the antilogarithm of the latitude is subtracted from the antilogarithm FH or HG of the distance from the intersection with the ecliptic, there results the antilogarithm of the arc HK, which is to be added to the point of intersection H when the latitude is southern, or subtracted when the latitude is northern.

The declinations and right ascensions are computed in a similar way, but with the help of the earlier diagram [Schematis], inserted on page 125, and by resolving the triangle HLM or HIG, given both the angle of inclination to the equator and its point of intersection, and the distance from the intersection with the equator. This, however, will become clearer from an example.

Let us therefore compute the latitude and longitude of the comet for December 20 completed, at 12 o'clock, that is, midnight, or for the beginning of December 21, reckoning from midnight. First, however, let the comet's distance from the intersection with the ecliptic be sought, and in this way.

Subtract the proper motion of 2° 30′ belonging to the completed day of December 20, taken from the Table of proper motion set out in days and hours in the preceding Section, from the comet's distance from the first observation up to the ecliptic, found on the preceding page, 32° 13′, and you will have the true distance from the intersection with the ecliptic corresponding to the given time, 29° 43′. If, on the other hand, you want the comet's distance from the intersection with the equator, you must take away that proper motion corresponding to the given time, 2° 30′, from the distance of 9° 46′, that is, the comet's distance from the first observation up to the equator. The working of the whole calculation for finding the latitude and longitude is as follows.

Distance from the first observation up to the ecliptic 32° 13′
Proper motion up to the beginning of December 20 2 30
Distance of the comet from the intersection with the ecliptic FH 29 43 Logar. 70176
Angle of the comet's orbit and the ecliptic H 74 0 Logar. 3951 *Ad.*
FK 74,127 28° 27′ *true southern latitude.*
Antilogarithm FH 14100
Antil. of the latitude FK 12,870 *Subt.*
Antilog. HK 1230 8° 58′ *Add., since the latitude is southern.*
Point of intersection H 28 34 ♉
AK 7 32 ♊ *the true longitude sought.*[232]

This example, then, shows clearly how our Table, that is, the following Ephemeris, was constructed. It should be noted, however, that the said calculation requires the angle of the orbit both with the ecliptic and with the equator, determined very accurately, and also the point of intersection of each circle, not only for any whole days of the apparition but also for their quarters, if the variation over that interval of time requires it. We did indeed seek, and also found, those angles and places of intersection precisely enough, in our judgement, as is evident from Sections IX and X, above all from the two smaller tables inserted on pages 111 and 112, in which both the angles and the places of intersection are shown for the individual days. But since there they are not yet extended to the quarters of days, we must now first set out the angles and places of intersection in the form in which we used them in constructing the Table, so that the lover of astronomy [Aſtrophilus] may be able all the more readily to compute and examine one or another example from our Ephemeris, from the very data themselves; although I would have you be quite certain that everything has been computed by us properly and most accurately. Indeed, I cannot marvel enough at how exactly everything agrees by the said method.

[232] a worked calculation, set as printed: rules stand under "2 30", above "29 43"; under 3951, above 74127; under 12870, above 1230; and under "28 34 ♉", above "7 32 ♊". The degree groups "2 30", "29 43", "74 0", "28 34" and "7 32" print no degree or minute marks; ♉ is the sign of Taurus, ♊ of Gemini. The second line's label reads "the beginning of December 20", where the prose above speaks of December 20 completed and the beginning of December 21; both as printed.

From this it is above all gathered with certainty that both the comet's proper motion and the angles of its orbit with each great circle were derived by us very exactly; otherwise, believe me, it would have been entirely in vain to deduce from them, in such order and proportion, the comet's varying position.

Table of the angles of the comet's orbit with both the ecliptic and the equator, for the individual days of the whole apparition and their quarters.

Month, day, in the current year 1652	Angle of orbit and ecliptic	Place of intersection with the ecliptic	Angle of orbit and equator	Place of intersection with the equator
December 21	74° 0′	28° 34′	63° 4′	66° 56′
22	74° 0′	28° 34′	63° 3′	66° 55′
23	73° 59′	28° 33′	63° 2′	66° 54′
24	73° 58′	28° 32′	63° 2′	66° 54′
25	73° 58′	28° 32′	63° 1′	66° 53′
26	73° 57′	28° 31′	63° 1′	66° 53′
27	73° 57′	28° 31′	63° 0′	66° 53′
28	73° 58′	28° 31′	63° 0′	66° 53′
29 12^h	73° 59′	28° 32′	63° 1′	66° 54′
6^h	73° 59′	28° 32′	63° 2′	66° 54′
12^h	74° 0′	28° 33′	63° 3′	66° 54′
6^h	74° 1′	28° 33′	63° 4′	66° 54′
30 12^h	74° 2′	28° 34′	63° 6′	66° 55′
6^h	74° 3′	28° 34′	63° 7′	66° 55′
12^h	74° 4′	28° 35′	63° 9′	66° 55′
6^h	74° 6′	28° 35′	63° 10′	66° 56′
31 12^h	74° 7′	28° 36′	63° 11′	66° 56′
6^h	74° 8′	28° 36′	63° 12′	66° 56′
12^h	74° 9′	28° 37′	63° 14′	66° 56′
6^h	74° 10′	28° 38′	63° 15′	66° 56′
January 1 12^h	74° 12′	28° 39′	63° 17′	66° 57′
6^h	74° 13′	28° 40′	63° 18′	66° 57′
12^h	74° 16′	28° 40′	63° 20′	66° 58′
6^h	74° 17′	28° 41′	63° 22′	66° 58′
2 12^h	74° 18′	28° 42′	63° 24′	66° 59′
6^h	74° 19′	28° 43′	63° 26′	67° 0′
12^h	74° 21′	28° 43′	63° 28′	67° 0′
6^h	74° 23′	28° 44′	63° 30′	67° 0′
3 12^h	74° 25′	28° 45′	63° 32′	67° 1′
6^h	74° 27′	28° 46′	63° 34′	67° 1′
12^h	74° 29′	28° 47′	63° 36′	67° 2′
6^h	74° 31′	28° 48′	63° 38′	67° 2′
4 12^h	74° 33′	28° 49′	63° 41′	67° 3′
6^h	74° 35′	28° 51′	63° 44′	67° 3′
12^h	74° 37′	28° 52′	63° 47′	67° 4′
6^h	74° 39′	28° 53′	63° 50′	67° 4′
5 12^h	74° 42′	28° 54′	63° 52′	67° 5′
6^h	74° 44′	28° 55′	63° 55′	67° 5′
12^h	74° 46′	28° 56′	63° 58′	67° 6′

Month, day, in the current year 1652	Angle of orbit and ecliptic	Place of intersection with the ecliptic	Angle of orbit and equator	Place of intersection with the equator
6^{h}	74° 49′	28° 58′	64° 1′	67° 6′
6 12^{h}	74° 52′	29° 0′	64° 4′	67° 7′
6^{h}	74° 54′	29° 1′	64° 7′	67° 7′
12^{h}	74° 57′	29° 3′	64° 10′	67° 7′
6^{h}	75° 0′	29° 5′	64° 14′	67° 8′
7 12^{h}	75° 3′	29° 7′	64° 18′	67° 8′
6^{h}	75° 6′	29° 8′	64° 21′	67° 8′
12^{h}	75° 9′	29° 10′	64° 24′	67° 9′
6^{h}	75° 12′	29° 13′	64° 27′	67° 9′
8 12^{h}	75° 15′	29° 15′	64° 30′	67° 10′
6^{h}	75° 18′	29° 17′	64° 33′	67° 10′
12^{h}	75° 21′	29° 19′	64° 36′	67° 11′
6^{h}	75° 24′	29° 20′	64° 39′	67° 11′

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There now follows the Ephemeris itself of the comet's true motions. The first column shows the days completed at midnight, and the hours. The second, the comet's longitude. The third, the motion in longitude over six hours. The fourth, the comet's latitude. The fifth, the motion in latitude over six hours. The sixth, the distance from the intersection with the ecliptic, both southern and northern. The seventh, the daily motion in its proper orbit. The eighth, the right ascension. The ninth, the declination. The tenth shows the distance from the intersection with the equator. In this way the Ephemeris shows abundantly how matters stood with these various motions over the whole time of its duration. Above all, one can see that some motions gradually increased and some decreased; and moreover that the comet was direct in its path, but with respect to the ecliptic always retrograde.

Ephemeris of the true motion of the comet of the year 1652, computed both with respect to the course of its path and with respect to the ecliptic and the equator, for the individual days of the whole apparition and their quarters.

[233] the table is set as printed in five ruled columns. In the first column the day number stands at the left of the cell and, from December 29 on, the hour at the right of the same cell; the rows for December 21–28 print no hour, and the rows after the first of each day print an hour and no day. The page prints the degree and minute figures without marks, under the heads "Gr.Min."; they are given here in degrees and minutes. Rules on the page separate each of the rows for December 21–28, and then each day's four rows (12, 6, 12, 6 hours). No zodiacal sign is printed in either "place of intersection" column. No label row stands below the last row.

December: days completed, current hours	Longitude	Motion in longitude, 6 hours	Latitude	Motion in latitude, 6 hours	Distance from the intersection with the ecliptic	Daily motion in its proper orbit	Right ascension	Declination	Distance from the intersection with the equator
20 12h	7° 32′ ♊	1° 2′	28° 27′ *A*	2° 47′	29° 43′ *A*	2° 56′	70° 15′	6° 28′ *A*	7° 16′ *A*
a.m. 6h	6° 30′	0° 57′	25° 40′	2° 42′	26° 47′	2° 50′	68° 53′	3° 52′	4° 20′
noon 12h	5° 33′	0° 53′	22° 58′	2° 48′	23° 57′	2° 55′	67° 37′	1° 20′	1° 30′
p.m. 6h	4° 40′	0° 48′	20° 10′	2° 24′	21° 2′	2° 31′	66° 16′	1° 16′ *B*	1° 25′ *B*
21 12h	3° 52′ ♊	0° 46′	17° 46′ *A*	2° 25′	18° 31′ *A*	2° 32′	65° 7′	3° 30′ *B*	3° 56′ *B*
a.m. 6h	3° 4′	0° 43′	15° 21′	2° 18′	15° 59′	2° 24′	63° 59′	5° 46′	6° 28′
noon 12h	2° 21′	0° 37′	13° 3′	2° 10′	13° 35′	2° 15′	62° 53′	7° 54′	8° 52′
p.m. 6h	1° 44′	0° 36′	10° 53′	2° 2′	11° 20′	2° 7′	61° 50′	9° 54′	11° 7′
22 12h	1° 8′ ♊	0° 35′	8° 51′ *A*	1° 58′	9° 13′ *A*	2° 3′	60° 49′	11° 46½′ *B*	13° 14′ *B*
a.m. 6h	0° 33′	0° 34′	6° 53′	1° 54′	7° 10′	1° 59′	59° 50′	13° 35′	15° 17′
noon 12h	29° 59′ ♉	31′	4° 59′	1° 49′	5° 11′	1° 53′	58° 53′	15° 21′	17° 16′
p.m. 6h	29° 28′	0° 30′	3° 10′	1° 43′	3° 18′	1° 47′	57° 57′	17° 0′	19° 9′
23 12h	28° 58′ ♉	27′	1° 27′ *A*	1° 38′	1° 31′ *A*	1° 42′	57° 4′	18° 34′ *B*	20° 56′ *B*
a.m. 6h	28° 31′	0° 26′	0° 11′ *B*	1° 33′	0° 11′ *B*	1° 37′	56° 13′	20° 4′	22° 38′
noon 12h	28° 5′	0° 27′	1° 44′	1° 31′	1° 48′	1° 35′	55° 22′	21° 29′	24° 15′
p.m. 6h	27° 38′	0° 26′	3° 15′	1° 24′	3° 23′	1° 27′	54° 31′	22° 51′	25° 50′
24 12h	27° 12′ ♉	25′	4° 39′ *B*	1° 20′	4° 50′ *B*	1° 24′	53° 44′	24° 7′ *B*	27° 17′ *B*
a.m. 6h	26° 47′	0° 23′	5° 59′	1° 18′	6° 14′	1° 21′	52° 57′	25° 19½′	28° 41′
noon 12h	26° 24′	0° 22′	7° 17′	1° 15′	7° 35′	1° 18′	52° 11′	26° 29′	30° 2′
p.m. 6h	26° 2′	0° 21′	8° 32′	1° 9′	8° 53′	1° 12′	51° 26′	27° 36′	31° 20′
25 12h	25° 41′ ♉	21′	9° 41′ *B*	1° 9′	10° 5′ *B*	1° 12′	50° 44′	28° 38′ *B*	32° 32′ *B*
a.m. 6h	25° 20′	0° 20′	10° 50′	1° 4′	11° 17′	1° 7′	50° 2′	29° 40′	33° 44′
noon 12h	25° 0′	0° 18′	11° 54′	1° 1′	12° 24′	1° 3′	49° 22′	30° 37′	34° 51′
p.m. 6h	24° 42′	0° 17′	12° 55′	0° 56′	13° 27′	0° 58′	48° 42′	31° 30′	35° 54′
26 12h	24° 25′ ♉	16′	13° 51′ *B*	0° 56′	14° 25′ *B*	0° 59′	48° 5′	32° 19′ *B*	36° 52′ *B*
a.m. 6h	24° 9′	0° 15′	14° 47′	0° 52′	15° 24′	0° 54′	47° 28′	33° 9′	37° 51′
noon 12h	23° 54′	0° 14′	15° 39′	0° 49′	16° 18′	0° 51′	46° 52′	33° 54′	38° 45′
p.m. 6h	23° 40′	0° 15′	16° 28′	0° 46′	17° 9′	0° 48′	46° 17′	34° 36′	39° 36′
27 12h	23° 25′ ♉	14′	17° 14′ *B*	0° 44′	17° 57′ *B*	0° 48′	45° 45′	35° 17′ *B*	40° 24′ *B*
a.m. 6h	23° 11′	0° 14′	17° 58′	0° 40′	18° 45′	0° 42′	45° 13′	35° 56′	41° 12′
noon 12h	22° 57′	0° 12′	18° 38′	0° 39′	19° 27′	0° 39′	44° 43′	36° 31′	41° 54′
p.m. 6h	22° 45′	0° 11′	19° 17′	0° 35′	20° 6′	0° 36′	44° 16′	37° 3′	42° 33′
28 12h	22° 34′ ♉	11′	19° 52′ *B*	0° 34′	20° 42′ *B*	0° 36′	43° 51′	37° 33′ *B*	43° 9′ *B*
a.m. 6h	22° 23′	0° 10′	20° 26′	0° 32′	21° 18′	0° 33′	43° 26′	38° 3′	43° 45′
noon 12h	22° 13′	0° 9′	20° 58′	0° 28′	21° 51′	0° 30′	43° 2′	38° 30′	44° 18′
p.m. 6h	22° 4′	0° 8′	21° 26′	0° 29′	22° 21′	0° 30′	42° 41′	38° 55′	44° 48′

December: days completed, current hours	Longitude	Motion in longitude, 6 hours	Latitude	Motion in latitude, 6 hours	Distance from the intersection with the ecliptic	Daily motion in its proper orbit	Right ascension	Declination	Distance from the intersection with the equator
29 12[h]	21° 56′ ♉ 8′		21° 55′ *B*	0° 29′	22° 51′ *B*	0° 30′	42° 20′	39° 20′ *B*	45° 18′ *B*
a.m. 6[h]	21° 48′	0° 8′	22° 24′	0° 27′	23° 21′	0° 30′	41° 59′	39° 45′	45° 48′
noon 12[h]	21° 40′	0° 7′	22° 53′	0° 24′	23° 51′	0° 25′	41° 38′	40° 10′	46° 18′
p.m. 6[h]	21° 33′	0° 7′	23° 17′	0° 23′	24° 16′	0° 24′	41° 18′	40° 31′	46° 43′
30 12[h]	21° 26′ ♉ 7′		23° 40′ *B*	0° 23′	24° 40′ *B*	0° 24′	40° 59′	40° 50′ *B*	47° 7′ *B*
a.m. 6[h]	21° 19′	0° 7′	24° 3′	0° 23′	25° 4′	0° 24′	40° 42′	41° 10′	47° 31′
noon 12[h]	21° 12′	0° 6′	24° 26′	0° 22′	25° 28′	0° 24′	40° 25′	41° 30′	47° 55′
p.m. 6[h]	21° 6′	0° 6′	24° 48′	0° 19′	25° 52′	0° 23′	40° 8′	41° 50′	48° 19′
31 12[h]	21° 0′ ♉	6′	25° 7′ *B*	0° 18′	26° 15′ *B*	0° 24′	39° 51′	42° 9′ *B*	48° 42′ *B*
a.m. 6[h]	20° 54′	0° 5′	25° 35′	0° 20′	26° 39′	0° 23′	39° 33′	42° 29′	49° 6′
noon 12[h]	20° 49′	0° 5′	25° 55′	0° 19′	27° 2′	0° 18′	39° 16′	42° 48′	49° 29′
p.m. 6[h]	20° 44′	0° 6′	26° 14′	0° 18′	27° 20′	0° 20′	39° 3′	43° 3′	49° 47′

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Ephemeris of the true motion of the comet of the year 1653, computed both with respect to the course of its path and with respect to the ecliptic and the equator, for the individual days of the whole apparition and their quarters.

January: days completed, current hours	Longitude	Motion in longitude, 6 hours	Latitude	Motion in latitude, 6 hours	Distance from the intersection with the ecliptic	Daily motion in its proper orbit	Right ascension	Declination	Distance from the intersection with the equator
1 January 12[h]	20° 38′ ♉ 6′		26° 32′ *B*	0° 18′	27° 40′ *B*	1° 20′	38° 49′	43° 19′ *B*	50° 6′ *B*
a.m. 6[h]	20° 32′	0° 6′	26° 51′	0° 19′	27° 59′	1° 19′	38° 34′	43° 35′	50° 26′
noon 12[h]	20° 28′	0° 6′	27° 9′	0° 18′	28° 17′	1° 18′	38° 20′	43° 51′	50° 44′

[234] the table is set as printed in ten ruled columns. The heads of the first column read "Decembr. Die compl. Hor. curr."; the day number stands only in the first row of each day, and the other rows are labelled on the page "m." (morning), "Merid." (noon) and "v." (evening), given here as a.m., noon and p.m. The page prints the figures without degree or minute marks, under the heads "Gr.Min."; they are given here in degrees and minutes. The zodiacal sign is printed only in the first row of each day and where the longitude passes from Gemini to Taurus. The letters *A* and *B* are printed only in the first row of each day and where the value passes from one to the other; the paragraph on the preceding page describes the distance from the ecliptic intersection as "both southern and northern". In the three motion columns each figure stands on the page half a row lower, between its row and the next; each is given here in the row above it, so that it stands against the interval it begins, and the last figure of each motion column stands below the last row of the page. Rules separate each day's four rows.

January: days completed, current hours	Longitude	Motion in longitude, 6 hours	Latitude	Motion in latitude, 6 hours	Distance from the intersection with the ecliptic	Daily motion in its proper orbit	Right ascension	Declination	Distance from the intersection with the equator
p.m. 6h	20° 23′	0° 5′	27° 16′	0° 17′	28° 35′	1° 18′	38° 8′	44° 6′	51° 2′
2 12h	20° 19′ ♉	4′	27° 44′	0° 18′ B	28° 53′ B	1° 18′	37° 55′	44° 21′ B	51° 20′ B
a.m. 6h	20° 15′	0° 4′	28° 1′	0° 17′	29° 11′	1° 18′	37° 41′	44° 36′	51° 38′
noon 12h	20° 11′	0° 4′	28° 19′	0° 18′	29° 29′	1° 18′	37° 27′	44° 51′	51° 56′
p.m. 6h	20° 7′	0° 4′	28° 33′	0° 14′	29° 44′	1° 15′	37° 15′	45° 4′	52° 11½′
3 12h	20° 4′ ♉	3′	28° 48′	0° 15′ B	29° 59′ B	1° 15′	37° 4′	45° 17′ B	52° 26½′ B
a.m. 6h	20° 1′	0° 3′	29° 2′	0° 14′	30° 14′	1° 15′	36° 54′	45° 30′	52° 41½′
noon 12h	19° 58′	0° 3′	29° 17′	0° 15′	30° 29′	1° 15′	36° 44′	45° 43′	52° 56½′
p.m. 6h	19° 55′	0° 3′	29° 31′	0° 14′	30° 44′	1° 15′	36° 33′	45° 56′	53° 11½′
4 12h	19° 53′ ♉	2′	29° 46′	0° 15′ B	30° 59′ B	1° 15′	36° 23′	46° 8′ B	53° 26′ B
a.m. 6h	19° 51′	0° 2′	29° 59′	0° 13′	31° 12′	1° 13′	36° 14′	46° 20′	53° 39′
noon 12h	19° 50′	0° 1′	30° 12′	0° 13′	31° 25′	1° 13′	36° 5′	46° 32′	53° 52′
p.m. 6h	19° 48′	0° 2′	30° 25′	0° 13′	31° 38′	1° 13′	35° 56′	46° 43′	54° 5′
5 12h	19° 46′ ♉	2′	30° 37′	0° 12′ B	31° 51′ B	1° 13′	35° 48′	46° 55′ B	54° 18′ B
a.m. 6h	19° 45′	0° 1′	30° 49′	0° 12′	32° 4′	1° 13′	35° 39′	47° 6′	54° 30′
noon 12h	19° 44′	0° 1′	31° 0′	0° 11′	32° 15′	1° 11′	35° 30′	47° 17′	54° 42′
p.m. 6h	19° 44′	0° 0′	31° 11′	0° 11′	32° 25′	1° 10′	35° 23′	47° 28′	54° 52½′
6 12h	19° 44′ ♉	0′	31° 21′	0° 10′ B	32° 34′ B	1° 9′	35° 19′	47° 36′ B	55° 1½′ B
a.m. 6h	19° 45′	0° 0′	31° 30′	0° 9′	32° 43′	1° 9′	35° 15′	47° 44′	55° 10½′
noon 12h	19° 46′	0° 1′	31° 39′	0° 9′	32° 52′	1° 9′	35° 9′	47° 52′	55° 19½′
p.m. 6h	19° 47′	0° 1′	31° 48′	0° 9′	33° 1′	1° 9′	35° 4′	48° 1′	55° 28½′
7 12h	19° 48′ ♉	1′	31° 57′	0° 9′ B	33° 10′ B	1° 9′	34° 59′	48° 9′ B	55° 37½′ B
a.m. 6h	19° 49′	0° 1′	32° 5′	0° 8′	33° 19′	1° 9′	34° 54′	48° 18′	55° 46½′
noon 12h	19° 50′	0° 1′	32° 13′	0° 8′	33° 27′	1° 8′	34° 49′	48° 25′	55° 54′
p.m. 6h	19° 51′	0° 1′	32° 20′	0° 7′	33° 33′	1° 6′	34° 45′	48° 31′	56° 0′

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[235] the table continues the ruled ten-column Ephemeris of the preceding page, under the same heads, with the year in its title printed "1653" and the order of the words "in prop. orb." printed "in orb. prop.". The heads of the first column read "Januarius. Die Hor. Compl.Cur."; the rows after the first of each day are labelled "m.", "Merid." and "v.", given here as a.m., noon and p.m. The figures stand without degree or minute marks, under the heads "Gr.Min."; they are given here in degrees and minutes. The Taurus sign and the letter *B* are printed only in the first row of each day. On this page the three motion columns stand half a row higher than the other columns, each figure between its row and the row above; each is given here in the row below it, so that it stands against the interval it ends. The first figure of each motion column therefore covers the interval from the last row of the preceding page (December 31, p.m.) to January 1, 12h, which the preceding page also prints, below its last row. Rules separate each day's four rows.

So that I may satisfy your curiosity all the more, my reader, here is also an accurate graphic delineation of the comet for you. In it we have shaded in, with the greatest care, both the comet's course for the individual days (and indeed for the preceding midnight) and its tail. Moreover, how it decreased from day to day, with respect to both the head and the tail; likewise what the comet's configuration with the fixed stars was on any given day; and other things of this kind: all these are clearly evident from that figure.

And so let us bring this Book I of the *Cometographia* to an end, since in these 11 Sections we have, as it were, paved the way to the subtler and greater things concerning comets, especially this comet of ours, that are to be uncovered in the books that follow. In these we shall take pains above all to find out its true seat: whether, namely, it completed its course in the air, or in the aether. Since this whole matter rests solely on parallaxes, we shall therefore investigate these too with due labour, and indeed by a most varied method. But first of all, in the following Book, we shall show in general on what grounds, with parallaxes set entirely aside, our comet proved to be celestial; and there, with the assent of the Supreme Deity, I intend to treat at sufficient length of some matters that are as pleasant as they are useful.

End of Book I. [FINIS LIBRI I.]

Diagram. A full-page engraved plate showing the course of the comet through the constellations from 20 December to 8 January. The constellations are drawn as figures over their stars. The comet's path is a single line running from the lower left up to the top centre; the head is drawn as a hatched disc at each day, with the day's figure beside it, and a tail is drawn at the heads of 20 December, 27 December and 3 January. Two graduated bands cross the plate: the ecliptic, running from the upper left down to the right, and the equator, horizontal below it. The lettering on the plate, as read:

- Title, across the head of the plate: "Course of the comet of 1652, from 20 December to 8 January, observed at Danzig by J. Hevelius." The word for "observed" is engraved [abſervatus].
- Constellations: Auriga (upper left); Perseus (upper right); Triangulum (right, above a ruled triangle drawn round its stars); Taurus (centre); Aries (right); Orion (left); Cetus (lower right); Eridanus (lower centre); Lepus (lower left).
- The comet's path, day figures from the top down: "January" beside 8, then 7, 6, 5, 4, 3, 2, 1, 31, 30, 29, 28, 27, "26 December", 25, 24, 23, 22, 21, and "20 December" at the lower end.
- Along the path line: "Orbit" below the equator and "of the comet" [?] above it.
- The ecliptic band, labelled "Ecliptic", with the numbered ticks 30, 20, 10 on the left and the sign ♊ above the band between 20 and 10; then 30, 20, 10 to the right, with the sign ♉ above the band between 20 and 10.
- The equator band, labelled "Equator", with the numbered ticks 90, 80, 70, 60, [?]0, 40, 30 from left to right.

- At the foot of the plate: "Fig. A." (left) and "The author engraved it" [Autor ſculpſit.] (right).

All the lettering on the plate was read. Three sorts are left open: the first figure of the equator tick between 60 and 40, which may be a 5 or a 6; the fifth letter of the word engraved along the path above the equator, which may be a t or an l; and the capital of the equator label, which may be Æ or A. The unnumbered ticks of the two bands and the stars carry no lettering.

Johannes Hevelius, Cometography, Book Two [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER SECUNDUS.]

That the Comet Was Ethereal Is Proved from Its Motion [Cometam æthereum fuiſſe, ex motu ejus probatur.]

Every age has indeed found that the world is ruled by various opinions. Above all, among both the older and the more recent philosophers, a very great dispute about comets arose so many centuries ago and has been carried on bitterly to this day: namely, whether comets exist and move in the air, or in the highest aether. It therefore seems incumbent on us too, now that the occasion has been given, to disclose our own opinion about this comet.

[Margin: De Cometarum ſede Philoſophi inter ſe acriter diſceptarunt.] *The philosophers have disputed bitterly among themselves about the seat of comets.*

That it was entirely ethereal is demonstrated most evidently, first of all, from the fact that, while it advanced with a proper motion in both longitude and latitude, it at the same time completed the daily, or common, motion most constantly, like all the other heavenly bodies. This certainly never happens to sublunary bodies, since they are compounded of wandering and inconstant earthly matter, as can be seen plainly in the genuine aerial meteors: the flying dragon, the torch, the beam, flying sparks, leaping goats, falling stars, the burning lance, and others of this kind.

[Margin: Cometam 1652 æthereum extitiſſe, ex motu ejus evincitur.] *The comet of 1652 is proved from its motion to have been ethereal.*

Next, the comet's proper motion, from the first time of its appearance right to the end, was supremely regular and proportionate, as is clearly evident from our Ephemeris of the comet's apparent motion. For just as its longitude, from its very first rising, grew slower against the order of the signs while keeping a certain proportion most constantly, so likewise its latitude always held strictly to its course, and was never disordered, still less wandering, that is, now greater, now smaller. The daily proper motion, it is true, was not always equal (for the comet was much faster at the beginning than at the end), but it decreased from day to day. And yet, since at all times it preserved the highest regularity and a proportionate equality within that inequality, as well as the ordinary proportion of its decline; and moreover since it never showed a motion that was at intervals now faster, now somewhat slacker, and altering itself in various ways, much less one that was wandering, inconstant, imperfect and uncertain

(as our most celebrated Keckermannus [Bartholomäus Keckermann] puts it, Book VI of the *Physics*, p. 1698);

[Margin: Cometæ motus proprius, quanquam inæqualis apparuerit, regularis tamen extitit.] *The comet's proper motion, although it appeared unequal, was nevertheless regular.*

but always kept the same tenor, of a kind found in no motion under the heavens, that is, in the aerial region. The most distinguished Fortunio Lyceto [Fortunio Liceti], though otherwise wholly devoted to the Peripatetic sect, agrees, in Book VI, chapter 32, p. 405 of *On New Stars and Comets* [de novis Aſtris & Cometis]. We therefore rightly conclude that the comet existed not in the air but in the aether itself.

[Margin: In aëreâ regione ſive ſublunari perpetuò motus datur vagus.] *In the aerial or sublunary region the motion found is always wandering.*

This is confirmed all the more by the fact that the comet, with its proper motion, most constantly described a circle that was exactly a great circle, and never perceptibly departed from its orbit or deviated to one side or the other (if you separate the annual motion of the earth from the comet's motion; otherwise, towards the end of the apparition, by reason of that motion, namely the earth's, when it becomes perceptible relative to the comet's motion, the paths of comets usually seem to curve somewhat; of this phenomenon more will be said below), but always kept its regard to fixed poles and divided the sphere into two equal parts, in the manner of all the heavenly bodies. From this one may argue as follows. Whatever body moves along a great circle that bisects the sphere, keeping fixed poles, is wholly ethereal. But our comet, throughout the whole time it lasted, scarcely strayed at all from the most exact course of a great circle, and kept fixed poles. Therefore it was plainly an ethereal body.

[Margin: Cometa ſub circulo inceſſit maximo.] *The comet advanced along a great circle.*

Some of the Peripatetics, too, very gladly assent to this argument, and freely admit that Aristotle himself held no other view than that those bodies whose motion takes place along an exact portion of a great circle are in the ethereal region, and that sublunary bodies never enjoy so regular and constant a course. Among others, the most learned philosopher Fortunio Liceti expressly indicates this in Book VI, chapter 31, p. 404 of *On New Stars and Comets*: *According to Aristotle, circular motion is twofold. One is simple: it belongs to celestial things alone, and it alone can take place in a great circle. The other is circular by predominance, and is present in subcelestial things, such as the element of fire and the uppermost air, many portions of which are forcibly thrust downward by the daily motion; because of the fluidity and rarity of its matter, and because of its resistance to motion in its proper place, where it naturally longs to rest, the air receives that motion with fluctuation. Hence it comes about that whatever things are contained in the uppermost air and in the element of fire, which are carried round the centre of the world with the motion of the heaven, with fluctuation and resistance, do not have a simple circular motion made exactly in a great circle. Therefore a comet in the elements, even if it is not carried*

towards its fuel nor driven by the winds, but is drawn by a star, will not be able to move exactly along a great circle. And according to Aristotle only celestial things have an exactly circular motion, towards which they have the greatest propensity, with no resistance at all. Hence we have truly established that every body whose motion was exactly along a portion of a great circle was necessarily, in Aristotle's view, in the ethereal region. So Liceti.

[Margin: Ariſtoteles ipſe conſentit, ætherea corpora moveri ſub portione circuli maximi.] *Aristotle himself agrees that ethereal bodies move along a portion of a great circle.*

[Margin: Cometa in Elementis nunquã ex mente Ariſtotelis & Lyceti fertur per circulum maximum.] *In the view of Aristotle and Liceti a comet in the elements is never carried along a great circle.*

Seneca, too, leans towards this opinion when he says, in Book VII of the *Natural Questions*, no. XXIII: *No regular and celestial fires have a crooked course. It is proper to a star to trace out its orbit. Whether other comets have done this, I do not know; two have done it in our own age.* Indeed, not only did those two do it, but so did all those comets whose accurate observations have reached us: namely the comets of the years 1531, 1532, 1533, 1577, 1585, 1590, 1607 and 1618, and likewise our own of 1652. Nor any doubt

[Margin: Omnes Cometæ, qui aliquãtò accuratiùs ſunt obſervati, minimè vagum & tumultuoſum habuerunt iter.] *All comets that have been observed with some accuracy have had a course that was anything but wandering and disorderly.*

would there be about all the rest, provided that the astronomers [Aſtroſophi] had not neglected to measure them carefully. So it is certain, again and again, that comets do not go confusedly and turbulently, as Seneca says, but always preserve the highest regularity, even in the very inequality of their motion. This is by no means possible in a wandering body, that is, in meteors, fiery and sublunary ones, which are tossed by various winds, drawn this way and that by their fuel, or driven by the force of this or that star; on the contrary, a wandering motion must necessarily be found in such a body. For things that are in the air, as experience teaches, stray from their course without law or proportion, and have an uneven and inconstant motion.

To this, it is true, someone might object that the conclusion, namely that the comet dwells in the aether, follows correctly from the syllogism above, but that the minor premise, namely that the comet described a great circle by its motion, is undoubtedly false; for the contrary can be demonstrated without much difficulty from Tycho himself. Just as this objection does seem utterly to destroy the foundation of our whole argument, so it will also be worth the trouble to examine it more scrupulously.

[Margin: Ex Tychone haud obſcurè infertur, nonnullum Cometam motu ſuo minimè deſcripſiſſè circulum maximum.] *From Tycho it is inferred quite clearly that some comet by no means described a great circle by its motion.*

We cannot deny, indeed, that Tycho also argued from this that comets performed their motion along a great circle: that the angle of the orbit with

both the ecliptic and the equator was entirely equal to itself throughout the whole time the comet lasted, and remained of the same size. This is clearly evident from what we cited above, in Book I, Section X, p. 114, from Tycho's Book II, chapter VI, on the comet of the year 1577, p. 103. It is therefore easily proved that those bodies in which the angle of inclination, or of the orbit to the ecliptic or to the equator, is not always found the same, do not describe an exact great circle, nor divide the sphere into two equal parts, much less have fixed poles. Moreover, it cannot be denied either that the angle of our comet's orbit to the ecliptic and to the equator varied from day to day. For at first it decreased over the space of some days; afterwards, having made a station, as it were, it increased again little by little right to the end. In the same way the point of intersection did not always stay in the same place in the heavens either. At first it was carried with a retrograde motion, though a very slow one; but afterwards it acquired a direct motion [?], and one that grew faster in succession, as we showed at length and in various ways, with very great labour, in the preceding Book, Section X. Moreover, we demonstrated there just as well, from observations most worthy of trust, that the case was the same with this angle for eight other comets, and that it was at all times inconstant and variable, however differently Tycho, Snellius and Crügerus [Peter Crüger], those leading lights [Coriphæi] among astronomers, may have thought. Hence we finally conclude firmly that in all comets the said angle and the nodes are variable, and indeed not with some fixed, perpetual variation, but for the most part with a varying one: each comet, that is, exhibits an almost individual change of the angle and of the node. From this, therefore, it may safely be gathered that, since the angle is not always the same but variable, comets must necessarily move along no great circle, but along another, perhaps smaller one, or rather along a markedly winding line.

[Margin: Quibus ex rationibus Tycho ſtatueritCometam exercuiſe motum ſub circulo maximo.] *The reasons for which Tycho determined that the comet performed its motion along a great circle.*

[Margin: Autor ultrò fatetur plurimorum Cometarum angulos orbitæ & Eclipticæ, nec non nodos variabiles extitiſe.] *The author freely admits that the angles between the orbit and the ecliptic of very many comets, and their nodes as well, were variable.*

[Margin: Vt ut alii,aliter ſenſerint.] *However differently others may have thought.*

And so this argument, advanced in favour of ethereal comets, can be turned round with no trouble to draw the contrary. For whatever body does not move in a great circle of the sphere is sublunary and elemental; but comets do not advance along a great circle of the sphere; therefore comets are sublunary and elemental. The major premise is most manifestly true; and the minor is clearly proved from the variable and inconstant angle of comets demonstrated in Section X of Book I. So it would seem that the plain contrary is more probable. Rightly, does it seem? For in truth, if the matter is weighed on a more accurate

balance, the falsity of this syllogism will easily be evident: namely, that the minor premise is defective, and that its proof, which is drawn from the variation of the angle of inclination to both the ecliptic and the equator, and also from the instability of the point of intersection, is false in every respect. For however variable this angle, together with the point of intersection, may be in all comets, it by no means follows that comets nevertheless cannot describe a great circle by their motion, even though this very point seems otherwise to some. So it seemed to Tycho, concerning the comet of the year 1577, in Book II, on the comet, chapter VI, p. 96, and p. 103, and likewise concerning the comet of the year 1590, in the Letter to the Landgrave, p. 176; and no less to Snellius and Crüger, concerning the comet of the year 1618, as can be seen from the passages cited in Section X of our preceding Book. For I am thoroughly convinced that these astronomers, as will be shown more fully shortly, went very far astray in their reasoning (which, however, I wish to be said without prejudice to their honour). This is more than sufficiently evident from the wandering stars [Stellis erraticis]: it cannot be denied of them that they dwell in the aether and have an ordered path in a great circle. And yet nothing at all is more certain and true than that all the planets, too, exhibit a variable and inconstant angle of inclination, although each in an entirely different way: in some, that is, the variation of this angle is greater or smaller, and in others, likewise, faster or slower.

[Margin: Argumentum admodum fallax eſt, quod à variatione anguli orbitæ atq; Nodi petitur pro Cometarum motu vago ſeu flexuoſo.] *The argument drawn from the variation of the angle of the orbit and of the node, in favour of a wandering or winding motion of comets, is quite fallacious.*

[Margin: Vt ut inclinatio Orbitæ atque Nodus varietur, nihilo tamen ſecius motus phænomeni peragi poteſt ſub circulo maximo.] *However the inclination of the orbit and the node may vary, the motion of the phenomenon can nonetheless take place along a great circle.*

[Margin: Id quod planetis dilucidè probatur, qui pariter non perpetuò eandem inclinationem ad Eclipticam & Æquatorem retinent.] *This is clearly proved by the planets, which likewise do not perpetually keep the same inclination to the ecliptic and the equator.*

In reality, indeed, the angle of inclination is almost perpetually constant and fixed (unless later ages should change something on account of some definite anomaly); and yet as regards appearance it is very changeable and unstable. To understand this correctly, one must know that the eccentric of each wanderer [Erronis] has its own definite inclination with respect to the ecliptic. For example, in Saturn the angle at which the limits are inclined to the ecliptic is 2° 32′; in Jupiter 1° 20′; in Mars 1° 50′ 30″; in Venus 3° 22′; in Mercury 6° 54′; and in the Moon 5°. Yet in the superior planets, as also in Venus, the latitudes are now greater, now smaller than the inclination, whereas in Mercury the latitude never equals the inclination but is always smaller. For Mercury, even when it is most remote from the Sun, is always nearer to it than to the earth.

The latitude of Saturn increases up to 2° 47′, that of Jupiter to 1° 40′, of Mars to 7, of Venus to 9°, of Mercury to 5°, and of the Moon to 5° 17′. Thus in all the planets the angle of inclination, or of the orbit and the ecliptic, always varies; but (as I would have you note well) only as regards appearance, since in itself, as we have just said, it is always constant. Indeed, according to some authors, not even the Sun itself, the most orderly of all the planets, is wholly free of every variation of obliquity, or of the angle of inclination of its orbit to the equator.

[Margin: Angulus inclinationis, in quocunq; Planetâ, quantus ſit.] *How great the angle of inclination is in each planet.*

[Margin: Angulus inc inationis tanl tùm quoad apparentiam variatur.] *The angle of inclination varies only as regards appearance.*

Moreover, the nodes of all the planets, like the points of intersection in comets, are also inconstant and mobile, though in an altogether different way. In some planets this motion of the nodes is carried according to the order of the signs, in others against the series of the signs; and likewise it is faster in some, slower in others. The node of Saturn advances each year 1′ 12″ in the order of the signs, relative to the vernal equinox; that of Jupiter only 3″ in the order of the signs; that of Mars 40″ in the order of the signs; that of Venus 47″ in the order of the signs; that of Mercury 1′ 25″ in the order of the signs. But the node of the Moon is carried forward 19° 19′ 43″ each year, and that against the series of the signs; although, with respect to the fixed stars, the nodes of all the other planets also move toward the preceding signs [in antecedentia].

[Margin: Nodi Planetarum quoq; variantur; & quâ ratione.] *The nodes of the planets also vary; and in what way.*

[Margin: Nodi, quanto ſpatio quotannis promoveantur.] *How great a distance the nodes are carried forward each year.*

Something similar is found in the Sun itself, since the intersection of the ecliptic and the equator, namely the point of the equinox, is by no means immobile either, but has a definite motion, however extremely slow. From this arises that well-known precession of the equinoxes, as is known to all astronomers and lovers of astronomy [Aſtrophilis].

[Margin: De præceſſione Æquinoctii.] *On the precession of the equinox.*

Now although the nodes of all the planets, and the angles of inclination of the orbit and the ecliptic, vary and move in different ways, now increasing and now decreasing, and they appear to describe no exactly great circle of the sphere, I think nobody is so rash as not to believe, nonetheless, that the planets move in the aether, that is, in the heaven itself. It is the same with comets: although their nodes and angles of inclination are mobile and variable, comets can nonetheless be celestial, just like the other planets.

[Margin: Etiamſi Planetæ diverſimodam Inclinationem exhibeant, nihilominus tamen certum eſt eos ſub circulis moveri maximis.] *Although the planets show an inclination that differs in different ways, it is nonetheless certain that they move under great circles.*

But to go into this matter still more precisely, and to reach at last an absolute conclusion, I say that the angle of inclination, of the planets as well as of the comets, is variable and changeable not in reality but only in appearance. This comes from the fact that the planets, and likewise the comets, do not always keep the same distance either from the Sun or from the Earth, but are now nearer to the Sun, now nearer to the Earth, and now farther away. For the more the planets approach the Sun and the earth, the more the angle of inclination increases; conversely, the more they recede from the Sun and the earth, the more that angle decreases, according to the motion of each planet. But if it could happen that the comets and the planets always kept exactly the same elongation from the Sun and the earth, and their distance between the Sun and the earth never changed, then that angle of inclination too would certainly be perpetually invariable. Supposing, therefore, that the planets and the comets always kept the same distance between the Sun and the earth, the inclination itself would also be truly immobile, according to the opinion of all mathematicians. This is clearly evident above all from Kepler's *Epitome of Copernican Astronomy* [Epitome Aſtron. Copernic.], Book VI, pp. 754 and 773, where he asserts that the inclination is always constant and fixed, unless later ages should change something on account of a transposition of the ecliptic, and that the latitudes appear to increase about the limits only through approach and recession.

[Margin: Cur Angulus inclinationis Planetarum tantùm quoad apparentiam exiſtat variabilis ?] *Why is the angle of inclination of the planets variable only as regards appearance?*

[Margin: Quâ ratione variatio iſtius anguli accidat.] *In what way the variation of this angle comes about.*

[Margin: Quomodo inclinatio datur immobilis.] *How the inclination is found to be immobile.*

And so you see, my lover of astronomy [mi Aſtrophile], that there is only a visible and apparent variation and change, not a true one, both of the latitudes at the limits and of the angle of inclination, or of the orbit, of the planets and the comets. Given, therefore, that the angle of inclination is in truth stable and invariable, it follows also that the motion of the planets and the comets takes place in an entirely great circle;

[Margin: Concluditur Cometas inſtar Planetarum verſari in ſummo æthere.] *It is concluded that comets, like the planets, move in the highest aether.*

and so that the comets too, just like the planets (as we argued above), move in the aether.

Next, I would also have you note that the apparent motion of the angle of inclination in comets is not irregular and winding, but supremely ordered and regular. That is, the said angle does not become now greater, now smaller, without any law and proportion of motion, but increases and decreases proportionally, and indeed according to the elongation. Thus, as the elongation increases, that angle decreases, and conversely, as the elongation decreases, the

angle increases, as is plain to everyone from optics; so much so that in this angle a certain wonderful and most constant variation, and a supremely regular inequality, is perpetually observed. Exactly the same happens with comets, both with ours and with all those whose angle of inclination we derived anew, with care, from sound observations in Section X of the preceding Book. For it is most manifestly clear there that the motion of their angle was always no less regular and proportionate, and that, like the planets, it had a definite increase, stations and decrease, as is clearly gathered from their longitudes, latitudes, right ascensions and declinations.

[Margin: Motus anguli inclinationis apparensCometarum, ratione elongationis à Sole & Terrâ, eſt regularis & ordinatus:] *The apparent motion of the angle of inclination of comets is regular and ordered according to their elongation from the Sun and the Earth.*

Therefore, since there is almost no difference between planets and comets as regards their varied motion, whether of longitude and latitude or of the nodes and the inclination, comets as well as planets certainly move in the highest ethereal region. Accordingly, that whole latter argument, which seemed to urge the contrary, collapses entirely, while our former one, namely that comets are celestial, stands altogether unshaken; for comets, like planets, are truly carried at all times in a great circle.

[Margin: Concluditur Cometas eſſe cœleſtes.] *It is concluded that comets are celestial.*

There is a further point. We found the angle of the orbit and the ecliptic, or the equator (as can be seen plainly from Sections IX and X of the preceding Book), always like itself and varying from day to day in a certain definite proportion, from each and every observation, whether those taken at the rising, where the orbit and the vertical almost always coincided, or those at the setting, where the orbit stood almost perpetually parallel to the horizon. It is therefore quite certain that the comet had either no notable parallax at all, or at least one far smaller than the Moon's. For if the comet had had even some perceptible parallax, the said angle of the orbit and the ecliptic, or the equator, would certainly have had to come out far smaller from the observations taken at the setting, with the orbit parallel to the horizon, on account of the parallax depressing the comet toward the horizon, than from those obtained at the rising, with the orbit roughly coinciding with the vertical. But since no such variation of this angle at all was detected, and the angle was found always equal to itself, as we have just said, the comet was free from all parallax whatever, and consequently moved in the highest aether.

[Margin: Vnde pateat Cometam anni 1652 parallaxin, Lunæ parallaxi longè minorem habuiſſe, atq; ſic in altiſſimo æthere incesſiſſe.] *From which it is evident that the comet of 1652 had a parallax far smaller than the Moon's parallax, and so moved in the highest aether.*

Finally, one may also argue with probability, from its proper motion in its orbit, that our comet was ethereal, since its daily motion (and that even when it

appeared fastest) did not exceed the Moon's daily motion. This would certainly have been otherwise if the phenomenon had dwelt below the Moon. Rea-

[Margin: Probabile argumentum,Cometas ferri in æthere.] *A probable argument that comets are carried in the aether.*

son, after all, agrees in the highest degree that the farther a body is removed from the earth, or rather from its own true centre, the more slowly it moves, as happens in all the heavenly bodies. For Mercury, being nearest to the Sun, the universal centre of the planets, is also the fastest of all (except the Moon, which acknowledges another centre); but Venus, Mars and Jupiter are slower in the measure that they are farther away than Mercury, so that Saturn, the most remote of all the planets, is also the slowest of all. Nor does this contradict Aristotle himself, as can be seen in Book II of *On the Heavens* [Lib.II. de Cœlo], where he asserts that the farther each star is from the earth, the slower it is in its own proper motion.

[Margin: Planetæ quò propiùs centro Vniverſi,eò velociores ſunt.] *The nearer the planets are to the centre of the universe, the faster they are.*

Now the Moon's daily motion sometimes rises to 12, 13, 14, or even 15°, whereas the comet's greatest daily motion, namely between December 20 and 21, was only 11° 16′. Whether it was somewhat faster still on the day before, we learned nothing certain; but supposing it was faster, it nevertheless did not exceed 13 or at most 14°, as far as one can rightly conjecture from the proportion of the daily motion. Therefore the comet had a higher seat than the Moon, even at the time when it was nearest to the earth. And if we weigh its daily motion on the remaining days of its appearance, decreasing notably from day to day, and near the end smaller even than half a degree, it is not absurd to conclude that by then it had moved above Mars, whose daily motion is otherwise 31′ 27″.

[Margin: Cometa 1652, omni tempore altior Lunâ extitit.] *The comet of 1652 was at all times higher than the Moon.*

[Margin: Circa exitum remotione ſuâ à Terrâ Martem penè ſuperavit.] *Near its end, in its distance from the Earth, it almost surpassed Mars.*

Exactly the same is affirmed [?] of all the other comets too, especially of the 8 whose proper motion we were able to derive duly, in Book I, Section X, from properly made observations; for their proper motion was somewhat slower still than that of our comet. Thus the greatest daily motion of the comet of 1577 was observed to be 6°; that of the comet of 1585 only 3°; of the comet of 1590, 7½°; of the comet of 1607, barely 10°; of the comet of 1618, only 2½°; and in some it was generally smaller still. Hence, by Aristotle's own reasoning, all of them dwelt far above the Moon.

[Margin: Ex ſententiâ Ariſtotelis diverſi Cometæ extiterunt cœleſtes.] *According to Aristotle's view, various comets were celestial.*

Therefore not only this comet but all the others whose sound observations have reached us agree with the heavenly bodies and the planets, and indeed with the Sun itself, in all their properties: both as regards the common motion

and the proper motion in their orbit, which is as regular as can be, always keeping the due proportion of speed, slowness and slackening; and also as regards longitudes, latitudes, right ascensions and declinations; then in having mobile nodes and a definite angle of inclination that is mobile and variable in an orderly way, and so a most constant course, in the manner of the stars, in a great circle; and finally, as regards the daily motion, in always showing it slower than the Moon's. Since this is so, we certainly conclude, again and again, that not only our comet but the other comets too existed in that most spacious theatre of the stars, and by no means in the elementary world, in which no such harmonious motion, perpetually constant on every side, is found.

[Margin: Autor deniq; concludit,certis ex rationibus, omnes Cometas fuisſe æthereos.] *Finally, the author concludes for definite reasons that all comets were ethereal.*

End of Book II. [FINIS LIBRI II.]

Johannes Hevelius, Cometography, Book Three [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER TERTIUS.]

On the Parallaxes, Derived by a Rougher Method, of Comets Supposed to Have Their Seat in Various Regions of the Air [De Parallaxibus, datâ, in diverſâ aëris regione Cometarum ſede, rudiori methodo deductis.]

When everything said in the preceding Book has been properly weighed, I do not doubt that all seekers of the truth, to a man, unless they altogether prefer the authority of the Peripatos [Peripati] and are governed by preconceived opinions, will admit with me that it has been shown clearly enough, even from the arguments adduced above alone, that the comet must rightly be counted among the heavenly bodies. Nevertheless, both for the sake of the Peripatetics, that they may at last come to their senses, and for the sake of the astronomers, that they may be made all the more certain of the sounder opinion, let us go further, and, applying the greatest diligence, let us explore whether any parallax at all, and then how great a one, belongs to our comet, so that at the same time we may rightly and accurately track down its true place and its distance from the earth, which is otherwise attempted in vain without parallaxes. This very thing will be all the more welcome to mathematicians and astrosophers [Aſtroſophis] who look more deeply into the heaven, the less anyone among the very many writers on this comet (with due respect, however, to the reputation of all) has yet attempted this task as its dignity and necessity require, and happily accomplished it. And yet the whole matter hangs on this, and the whole dispute between the astronomers and the Peripatetics can be settled only once the parallaxes of comets have been soundly investigated and sufficiently demonstrated.

[Margin: Vlteriore inveſtigatione Autor detegere proponit,utrùm aliqua, & quãta Com. 1652. competat parallaxis ?] *By further investigation the author*

proposes to discover whether any parallax, and how great a one, belongs to the comet of 1652.

[Margin: Absq; parallaxi nullo modo verus Cometæ locus innoteſcit.] *Without parallax the true place of the comet can in no way be known.*

Hence we wonder that, after the noble Tycho, that marvel among astronomers, scarcely anyone among so many most distinguished and most learned men, both of the previous century and of our own, has come forward who, in the same way as Tycho himself, by so many routes, overcoming so many windings and rocks, with such skill and labour, has derived the parallaxes of even a single comet from the one that arose in 1577 up to now, even though in 1618 there appeared one whose like has scarcely shone since the creation of the world. Far be it from us, however, that I should accuse any one of them of negligence of any kind. For most comet-writers [Cometographorum] mostly occupy and enslave their minds with vain astrological predictions and divinations, built on no solid foundations, not so much for the sake of truth and of advancing the study of the stars, as for the sake of gain and of pleasing and entertaining common people; so that they very rarely investigate the nature and motion of the sublime ethereal bodies; and even if, at the very most, some-

[Margin: Nemo adeò ſollicitè ut Tycho Brahæus parallaxibus operam dedit.] *Nobody has devoted himself to parallaxes as carefully as Tycho Brahe.*

[Margin: Cometographi, plerunq; vanis prædictionibus ſe ſe oblectant.] *Comet-writers mostly amuse themselves with vain predictions.*

times wish to, they are scarcely accustomed to investigating these things properly, that is to say, by the geometrical route. Indeed, to penetrate and unravel each and every thing about comets with exactness is, just as it is nearly the most difficult of all matters in astronomy, so also a task that needs the greatest subtlety, labour and industry: this, however, as is their custom, the astrologers for the most part shun. We would therefore be unjust toward such men if we demanded anything more of them than they are able to deliver. But most of the rest, very learned men and true astronomers, have left this labour undone, I believe, for no other reason than that they were equipped neither with adequate instruments nor with other people's observations, most worthy of trust, accurate and many-sided; and where these are denied, it is certainly vain, even for Tycho himself, to produce anything worthy of praise. For the observations of comets from which parallaxes are to be derived are not carried out with common, toy-like and childish instruments, still less with the naked eye or merely by stretching out a thread, since the matter is extremely subtle and sometimes turns on the very smallest quantities. Rather, the instruments must likewise be the best of all, of proper size, made of solid material, entirely free of every fault, and likewise divided most finely and most accurately into single minutes and parts of minutes. Moreover, it is required above all that in making celestial observations we should also be extremely circumspect and should always attend to the highest precision that can ever be achieved, as those know especially who have worked more diligently in this arena [hoc in

pulvere] and have been well trained in this art by the constant practice of many years.

[Margin: Cometarum negotiumomnium ferè eſt difficillimum.] *The business of comets is nearly the most difficult of all.*

[Margin: Niſi juſtè elaboratis inſtrumentis fide dignisſimas obſervationes acquiſiveris,nihil quicquam certi circa parallaxes elicies.] *Unless you have obtained observations most worthy of trust with properly made instruments, you will draw nothing at all certain about parallaxes.*

[Margin: Requiſita perquàm necesſaria ad peragendas obſervationes.] *Requirements that are absolutely necessary for carrying out observations.*

Since this is so, and since, by the favour of the Divine Power, I had obtained with my most solid instruments — namely the large azimuthal quadrant, the sextant and others — not a few most exquisite observations, relying on which I was confident that I could draw the parallaxes of this comet out of such deep hiding into the light, I set about this work with the greatest eagerness, and did not fear this Herculean labour in the slightest: however great the difficulty that presented itself in tracking down the comet's parallaxes, and far greater, certainly, than with other new phenomena, such as fixed stars, which entirely lack proper motion and stand in a perpetually fixed place. For our comet was endowed at first not only with a very swift proper motion, but also with an unequal one (although one that grew successively and proportionally slower). Then, during the whole time it lasted, it was not possible to observe its passage through the meridian even once: both because of the comet's excessive altitude around its rising and the inconvenience of the observatory, and because in its last days it never reached the meridian. All of this certainly produced no ordinary perplexity in the intricate business of the parallaxes.

[Margin: Multò difficiliùs Cometas, quàm novas Stellas calculo perveſtigare.] *It is much more difficult to track down comets by calculation than new stars.*

For this reason it can scarcely be told, indeed it would scarcely be credible to any but those more experienced in these matters, how much labour and time it cost before merely all those things that are necessarily required in advance for calculating the parallaxes had been investigated by due geometrical reasoning: namely, for each of so many observations, the true time from the altitudes and azimuths of the fixed stars; and from the comet's altitudes and azimuths, its longitudes, latitudes, right ascensions and declinations; and from the distances of various fixed stars from the comet, likewise the longitudes, latitudes, right ascensions and declinations; then, no less, for all the observations, the true place of the Sun and the distance of the com-

[Margin: Quænam initiò ab autore exploranda fuerunt.] *What the author had to investigate at the outset.*

et from the Sun; in turn, the angle between the comet's orbit and the ecliptic, both from the altitudes and azimuths of the comets and from the distances; besides this, the point of intersection of the said orbit and the ecliptic, and the comet's proper motion for each day; finally, from the right ascensions and

declinations, the angle between the comet's orbit and the equator, together with the point of intersection of these same circles — to say nothing of very many other things which have been left out of this work for the sake of brevity.

And although all these things have already been investigated by us with great care, as is clear from the first Book, and reduced to tables, nothing more has yet been accomplished than that the first solid foundation for deriving the parallaxes, and the road for getting that far, has been very well laid. It follows, therefore, that with GOD we should gird ourselves for the principal business itself, the parallactic one, for whose sake we have toiled through all that went before.

But before the parallaxes of this comet are derived more artfully, the aim is first to demonstrate to everyone by a plainer and simpler method, through diagrams set before the eye, that the comet was situated far above the Moon; and to demonstrate it above all to those who have been little devoted to such most intricate and most abstruse astronomical matters, or who are unable to follow those subtler methods of investigating parallaxes. For I am convinced that in this way not only those who are wholly ignorant of mathematics, but even those entirely without any learning, provided they have some knowledge of letters, can be brought to understand and grasp that the comet was subject to no parallaxes at all, or to very small ones, and indeed to believe most firmly that it existed in the highest aether.

[Margin: Autor primùm conſtituit rudiori modo demonſtrare, Cometam ſupra Lunam incesſisſe.] *The author has resolved first to demonstrate by a rougher method that the comet moved above the Moon.*

But let us approach the matter itself. It should be known, then, that the comet, as the journal of observations shows, on December 26 at about 5^{h} in the evening formed a straight line with the two stars in the foot of Perseus, and stood off from the Heel by nearly as great a distance as this star stands from the other star in the foot; and that it also kept roughly this straight line through nearly the whole night, until the comet set, except that little by little it tended more and more towards Circius, and moved off a little farther upward from the Heel.

[Margin: Cometa cum duabus in pede Perſëi Stellis conſtituit lineam rectam.] *The comet formed a straight line with two stars in the foot of Perseus.*

From this observation, therefore, which of all the others most struck the eyes of the onlookers, learned and unlettered alike, and which at the same time seems to serve our purpose exceptionally well, we shall first examine the parallaxes by a rougher route, and shall show to the eye that the comet in no way existed in the elementary region. And to make the matter all the clearer, we shall consider the comet as if it had dwelt in that region of the air in which meteors are otherwise generated; and indeed, for better understanding, in the highest part of that same region, namely at a distance of 20 German miles, 15 of which make one degree. Yet, as has been shown clearly enough in its place, even the twilight itself, or the highest air, which according to the greater chorus

of philosophers consists of the lightest and subtlest vapours of all, scarcely rises to 13 miles in height. Indeed some, like Kepler on p. 33 of *De Cometis*, assert that the region of the air, or atmosphere, ends right at the highest summits of the mountains: hence on Mount Olympus in Asia and on the snowy peaks of Peru one can no longer live, for want of that breath which we call air, and which we cannot do without inhaling.

[Margin: Cometa in inferiori aëris regione ad 20 ſcilicet mill. exhibetur.] *The comet is presented in the lower region of the air, namely at 20 miles.*

[Margin: Crepuſculum vix ad 13 mill. aſcendit.] *Twilight scarcely rises to 13 miles.*

But supposing, though not granting, that the comet was 20 miles distant from us, the question is how great and of what kind the difference of aspect [diverſitas adſpectus], or parallax, would have been for the comet. This will indeed soon become most evident if we draw our phenomenon, set in one straight line with the two little stars in the foot of Perseus, at different times and at different altitudes, with the parallaxes appropriate to that same distance from the earth: namely, how it would have behaved with respect to those two stars in the said position; and that it could not always have kept a straight line through the whole night, as was observed by everyone everywhere, but rather that it would have shown a momentary variation of its distance with respect to these little stars, and at almost every moment would have formed different triangles, and these so varied that it could scarcely be put into words. But the matter will become clearer with a diagram. And by means of this Parallactic Table, which we chose to construct for this purpose for every two degrees of altitude of any phenomenon and for widely differing distances from the earth, the lowest of which is assumed to be only two, and the highest 10,000 semidiameters of the Earth [Semid. T], anyone may at once and with no trouble at all perceive, at all these distances from the Earth, the parallax corresponding to any given distance and altitude of a phenomenon. And conversely, given the parallax of altitude of any phenomenon, the distance of any phenomenon from the earth may also at once be evident. Since this table is not only very useful for this purpose of ours but can also readily be applied hereafter to very many other matters, I have gladly chosen to insert it here, especially since no one up to now has ever constructed one for so great a distance of a phenomenon from the earth.

[Margin: Mira diverſitas adſpectus Comet. 20 mill. à terrâ remoti.] *The remarkable parallax of a comet 20 miles distant from the earth.*

[Margin: Tabula Parallactica.] *The Parallactic Table.*

Table of Parallaxes of Altitude [TABULA PARALLAXIUM ALTITUDINIS.][236]

Degrees of apparent altitude	2	3	4	5	6	7	8	9	10	12	15
Horizon	30° 0′	19° 28′	14° 29′	11° 32′	9° 36′	8° 13′	7° 11′	6° 23′	5° 44′	4° 47′	3° 50′
2	29° 59′	19° 28′	14° 28′	11° 32′	9° 35′	8° 12′	7° 11′	6° 23′	5° 44′	4° 47′	3° 49′
4	29° 55′	19° 25′	14° 26′	11° 31′	9° 34′	8° 12′	7° 10′	6° 22′	5° 43′	4° 46′	3° 49′
6	29° 49′	19° 22′	14° 24′	11° 28′	9° 33′	8° 10′	7° 9′	6° 21′	5° 42′	4° 45′	3° 48′
8	29° 41′	19° 16′	14° 20′	11° 25′	9° 30′	8° 8′	7° 7′	6° 19′	5° 41′	4° 44′	3° 47′
10	29° 30′	19° 10′	14° 15′	11° 22′	9° 27′	8° 5′	7° 4′	6° 17′	5° 39′	4° 42′	3° 46′
12	29° 17′	19° 2′	14° 9′	11° 17′	9° 23′	8° 2′	7° 1′	6° 14′	5° 37′	4° 41′	3° 44′
14	29° 1′	18° 52′	14° 2′	11° 11′	9° 18′	7° 58′	6° 58′	6° 11′	5° 34′	4° 38′	3° 43′
16	28° 44′	18° 41′	13° 54′	11° 5′	9° 13′	7° 54′	6° 54′	6° 8′	5° 31′	4° 36′	3° 40′
18	28° 24′	18° 29′	13° 45′	10° 58′	9° 7′	7° 48′	6° 50′	6° 4′	5° 28′	4° 33′	3° 38′
20	28° 1′	18° 15′	13° 35′	10° 50′	9° 1′	7° 43′	6° 45′	6° 0′	5° 24′	4° 29′	3° 35′
22	27° 37′	18° 0′	13° 24′	10° 41′	8° 53′	7° 37′	6° 39′	5° 55′	5° 19′	4° 26′	3° 33′
24	27° 11′	17° 44′	13° 12′	10° 32′	8° 45′	7° 30′	6° 33′	5° 50′	5° 14′	4° 22′	3° 29′
26	26° 42′	17° 26′	12° 59′	10° 21′	8° 37′	7° 23′	6° 27′	5° 44′	5° 9′	4° 18′	3° 26′
28	26° 12′	17° 7′	12° 45′	10° 10′	8° 28′	7° 15′	6° 20′	5° 38′	5° 4′	4° 13′	3° 22′
30	25° 40′	16° 47′	12° 30′	9° 58′	8° 18′	7° 6′	6° 13′	5° 31′	4° 58′	4° 8′	3° 19′
32	25° 5′	16° 25′	12° 14′	9° 46′	8° 8′	6° 58′	6° 5′	5° 24′	4° 52′	4° 3′	3° 14′
34	24° 29′	16° 3′	11° 58′	9° 33′	7° 57′	6° 48′	5° 57′	5° 17′	4° 45′	3° 58′	3° 10′
36	23° 52′	15° 39′	11° 40′	9° 19′	7° 45′	6° 38′	5° 48′	5° 9′	4° 38′	3° 52′	3° 5′
38	23° 12′	15° 14′	11° 22′	9° 4′	7° 33′	6° 28′	5° 39′	5° 1′	4° 31′	3° 46′	3° 1′
40	22° 31′	14° 48′	11° 2′	8° 49′	7° 20′	6° 17′	5° 30′	4° 53′	4° 24′	3° 40′	2° 56′
42	21° 49′	14° 21′	10° 42′	8° 33′	7° 7′	6° 6′	5° 20′	4° 44′	4° 16′	3° 33′	2° 50′
44	21° 5′	13° 52′	10° 22′	8° 16′	6° 53′	5° 54′	5° 10′	4° 35′	4° 8′	3° 26′	2° 45′
46	20° 19′	13° 23′	10° 0′	7° 59′	6° 39′	5° 42′	4° 59′	4° 26′	3° 59′	3° 19′	2° 39′
48	19° 33′	12° 54′	9° 38′	7° 41′	6° 24′	5° 29′	4° 48′	4° 16′	3° 50′	3° 12′	2° 34′
50	18° 45′	12° 22′	9° 15′	7° 23′	6° 9′	5° 16′	4° 37′	4° 6′	3° 41′	3° 4′	2° 27′
52	17° 56′	11° 51′	8° 51′	7° 4′	5° 53′	5° 3′	4° 25′	3° 55′	3° 32′	2° 56′	2° 21′
54	17° 5′	11° 18′	8° 27′	6° 45′	5° 37′	4° 49′	4° 13′	3° 45′	3° 22′	2° 48′	2° 15′
56	16° 14′	10° 45′	8° 2′	6° 25′	5° 21′	4° 35′	4° 0′	3° 34′	3° 12′	2° 40′	2° 8′
58	15° 22′	10° 11′	7° 37′	6° 5′	5° 4′	4° 20′	3° 48′	3° 23′	3° 2′	2° 32′	2° 1′
60	14° 29′	9° 36′	7° 11′	5° 44′	4° 47′	4° 6′	3° 35′	3° 11′	2° 52′	2° 23′	1° 55′
62	13° 35′	9° 0′	6° 44′	5° 23′	4° 29′	3° 51′	3° 22′	2° 59′	2° 41′	2° [?]5′	1° 48′
64	12° 40′	8° 24′	6° 18′	5° 2′	4° 11′	3° 35′	3° 8′	2° 48′	2° 31′	2° 6′	1° 40′
66	11° 44′	7° 48′	5° 50′	4° 40′	3° 53′	3° 20′	2° 55′	2° 35′	2° 20′	1° 56′	1° 33′
68	10° 48′	7° 10′	5° 22′	4° 18′	3° 35′	3° 4′	2° 41′	2° 23′	2° 9′	1° 47′	1° 26′
70	9° 51′	6° 33′	4° 54′	3° 55′	3° 16′	2° 48′	2° 27′	2° 11′	1° 58′	1° 38′	1° 18′
72	8° 53′	5° 55′	4° 26′	3° 33′	2° 57′	2° 32′	2° 13′	1° 58′	1° 46′	1° 29′	1° 11′
74	7° 55′	5° 16′	3° 57′	3° 10′	2° 38′	2° 15′	1° 58′	1° 45′	1° 35′	1° 19′	1° 3′

[236] the head of the table, spanning the distance columns, reads "At a distance from the centre of the Earth, in semidiameters of the Earth" [AD DISTANTIAM A TERRÆ CENTRO SEMIDIAMM. TERRÆ.]. The figures 2 to 15 heading the columns are those distances. The left column is headed "Degrees of apparent altitude" [Grad. Viſæ Altitud.]; each distance column is headed "Gr. M." (degrees, minutes), and each cell gives the parallax of altitude in degrees and minutes. The rows are printed in groups of three, divided by rules.

Degrees of apparent altitude	2	3	4	5	6	7	8	9	10	12	15
76	6° 57′	4° 38′	3° 28′	2° 46′	2° 19′	1° 59′	1° 44′	1° 32′	1° 23′	1° 9′	0° 55′
78	5° 58′	3° 59′	2° 59′	2° 23′	1° 59′	1° 42′	1° 29′	1° 20′	1° 12′	1° 0′	0° 48′
80	4° 59′	3° 19′	2° 29′	1° 59′	1° 40′	1° 25′	1° 15′	1° 6′	1° 0′	0° 50′	0° 40′
82	3° 59′	2° 40′	2° 0′	1° 36′	1° 20′	1° 8′	0° 54′	0° 53′	0° 48′	0° 40′	0° 32′
84	3° 0′	2° 0′	1° 30′	1° 12′	1° 0′	0° 51′	0° 45′	0° 40′	0° 36′	0° 30′	0° 24′
86	2° 0′	1° 20′	1° 0′	0° 48′	0° 40′	0° 34′	0° 30′	0° 27′	0° 24′	0° 20′	0° 16′
88	1° 0′	0° 40′	0° 30′	0° 24′	0° 20′	0° 17′	0° 15′	0° 13′	0° 12′	0° 10′	0° 8′

Table of Parallaxes of Altitude [TABULA PARALLAXIUM ALTITUDINIS·][237]

Degrees of apparent altitude	20	25	30	35	40	45	50	55	60	65	70
Horizon	2° 52′	2° 18′	1° 55′	1° 38′	1° 26′	1° 16′	68′ 45″	62′ 30″	57′ 18″	52′ 53″	49′ 6″
2	2° 52′	2° 17′	1° 55′	1° 38′	1° 26′	1° 16′	68′ 43″	62′ 28″	57′ 16″	52′ 51″	49′ 5″
4	2° 51′	2° 17′	1° 54′	1° 38′	1° 25′	1° 16′	68′ 35″	62′ 21″	57′ 10″	52′ 46″	49′ 0″
6	2° 51′	2° 17′	1° 54′	1° 37′	1° 25′	1° 16′	68′ 23″	62′ 10″	56′ 59″	52′ 37″	48′ 51″
8	2° 50′	2° 16′	1° 53′	1° 37′	1° 25′	1° 16′	68′ 5″	61′ 54″	56′ 44″	52′ 23″	48′ 38″
10	2° 49′	2° 15′	1° [?]3′	1° 37′	1° 25′	1° 15′	67′ 43″	61′ 33″	56′ 26″	52′ 5″	48′ 22″
12	2° 48′	2° 15′	1° 52′	1° 36′	1° 24′	1° 15′	67′ 15″	61′ 8″	56′ 3″	51′ 44″	48′ 2″
14	2° 47′	2° 13′	1° 51′	1° 35′	1° 23′	1° 14′	66′ 43″	60′ 40″	55′ 36″	51′ 19″	47′ 39″
16	2° 45′	2° 12′	1° 50′	1° 34′	1° 23′	1° 13′	66′ 6″	60′ 5″	55′ 5″	50′ 50″	47′ 13″
18	2° 44′	2° 11′	1° 49′	1° 33′	1° 22′	1° 13′	65′ 24″	59′ 27″	54′ 30″	50′ 18″	46′ 42″
20	2° 42′	2° 9′	1° 48′	1° 32′	1° 21′	1° 12′	64′ 37″	58′ 44″	53′ 51″	49′ 42″	46′ 9″
22	2° 39′	2° 8′	1° 46′	1° 31′	1° 20′	1° 11′	63′ 45″	57′ 57″	53′ 8″	49′ 2″	45′ 32″
24	2° 37′	2° 6′	1° 45′	1° 30′	1° 19′	1° 10′	62′ 49″	57′ 6″	52′ 21″	48′ 19″	44′ 53″
26	2° 35′	2° 4′	1° 43′	1° 28′	1° 17′	1° 9′	61′ 48″	56′ 11″	51′ 30″	47′ 32″	44′ 8″
28	2° 32′	2° 1′	1° 41′	1° 27′	1° 16′	1° 7′	60′ 43″	55′ 11″	50′ 35″	46′ 42″	43′ 22″
30	2° 29′	1° 59′	1° 39′	1° 25′	1° 15′	1° 6′	59′ 33″	54′ 8″	49′ 37″	45′ 48″	42′ 32″
32	2° 26′	1° 57′	1° 37′	1° 23′	1° 13′	1° 5′	58′ 19″	53′ 1″	48′ 35″	44′ 51″	41′ 39″
34	2° 23′	1° 54′	1° 35′	1° 21′	1° 11′	1° 3′	57′ 0″	51′ 49″	47′ 30″	43′ 51″	40′ 43″
36	2° 19′	1° 51′	1° 32′	[?]° 19′	1° 10′	1° 1′	55′ 38″	50′ 34″	46′ 22″	42′ 47″	39′ 44″
38	2° 15′	1° 48′	1° 30′	1° 17′	1° 8′	1° 0′	54′ 11″	49′ 15″	45′ 9″	41′ 41″	38′ 42″
40	2° 12′	1° 45′	1° 28′	1° 15′	1° 6′	0° 59′	52′ 40″	47′ 53″	43′ 54″	40′ 31″	37′ 37″
42	2° 8′	1° 42′	1° 25′	1° 13′	1° 4′	0° 57′	51′ 6″	46′ 27″	42′ 35″	39′ 18″	36′ 30″
44	2° 4′	1° 39′	1° 22′	1° 11′	1° 2′	0° 55′	49′ 28″	44′ 58″	41′ 13″	38′ 3″	35′ 20″
46	1° 59′	1° 36′	1° 20′	1° 8′	1° 0′	0° 53′	47′ 46″	43′ 25″	39′ 48″	36′ 44″	34′ 7″
48	1° 55′	1° 32′	1° 17′	1° 6′	0° 58′	0° 51′	46′ 1″	41′ 50″	38′ 20″	35′ 22″	32′ 52″
50	1° 51′	1° 28′	1° 14′	1° 3′	0° 55′	0° 49′	44′ 12″	40′ 11″	36′ 50″	34′ 0″	31′ 34″

[237] the head of the table reads, as on the preceding page, "At a distance from the centre of the Earth, in semidiameters of the Earth" [AD DISTANTIAM A TERRÆ CENTRO SEMIDIAMM. TERRÆ.], and the figures 20 to 70 heading the columns are those distances. The columns for 20 to 45 are headed "Gr. M." and give degrees and minutes; the columns for 50 to 70 are headed for minutes and seconds (printed "M.Sec.", "M.Sec", "Mi.Se.", "M Sec", "Mi.Se.") and give minutes and seconds. The rows are printed in groups of three, divided by rules.

Degrees of apparent altitude	20	25	30	35	40	45	50	55	60	65	70
52	1° 46′	1° 25′	1° 11′	1° 1′	0° 53′	0° 47′	42′ 20″	38′ 29″	35′ 17″	32′ 34″	30′ 14″
54	1° 41′	1° 21′	1° 7′	0° 58′	0° 50′	0° 45′	40′ 26″	36′ 45″	33′ 41″	31′ 5″	28′ 52″
56	1° 36′	1° 17′	1° 4′	0° 55′	0° 48′	0° 43′	38′ 27″	34′ 57″	32′ 2″	29′ 35″	27′ 28″
58	1° 31′	1° 13′	1° 1′	0° 52′	0° 46′	0° 40′	36′ 26″	33′ 7″	30′ 22″	28′ 2″	26′ 1″
60	1° 26′	1° 9′	0° 57′	0° 49′	0° 43′	0° 38′	34′ 23″	31′ 15″	28′ 39″	26′ 27″	24′ 33″
62	1° 21′	1° 5′	0° 54′	0° 46′	0° 40′	0° 36′	32′ 17″	29′ 21″	26′ 54″	24′ 50″	23′ 3″
64	1° 15′	1° 0′	0° 50′	0° 43′	0° 38′	0° 33′	30′ 8″	27′ 24″	25′ 7″	23′ 11″	21′ 32″
66	1° 10′	0° 56′	0° 47′	0° 40′	0° 35′	0° 31′	27′ 58″	25′ 25″	23′ 18″	21′ 31″	19′ 59″
68	1° 4′	0° 52′	0° 43′	0° 37′	0° 32′	0° 29′	25′ 45″	23′ 25″	21′ 28″	19′ 49″	18′ 24″
70	0° 59′	0° 47′	0° 39′	0° 34′	0° 29′	0° 26′	23′ 31″	21′ 23″	19′ 36″	18′ 5″	16′ 48″
72	0° 53′	0° 42′	0° 36′	0° 30′	0° 27′	0° 23′	21′ 15″	19′ 19″	17′ 42″	16′ 21″	15′ 10″
74	0° 47′	0° 38′	0° 32′	0° 27′	0° 24′	0° 21′	18′ 57″	17′ 14″	15′ 48″	14′ 35″	13′ 32″
76	0° 42′	0° 33′	0° 28′	0° 24′	0° 21′	0° 18′	16′ 38″	15′ 7″	13′ 52″	12′ 48″	11′ 53″
78	0° 36′	0° 29′	0° 24′	0° 20′	0° 18′	0° 16′	14′ 18″	13′ 0″	11′ 55″	11′ 0″	10′ 13″
80	0° 30′	0° 24′	0° 20′	0° 17′	0° 15′	0° 13′	11′ 56″	10′ 51″	9′ 57″	9′ 11″	8′ 32″
82	0° 24′	0° 19′	0° 16′	0° 14′	0° 12′	0° 11′	9′ 34″	8′ 42″	7′ 58″	7′ 22″	6′ 50″
84	0° 18′	0° 14′	0° 12′	0° 10′	0° 9′	0° 8′	7′ 11″	6′ 32″	5′ 59″	5′ 32″	5′ 8″
86	0° 12′	0° 10′	0° 8′	0° 7′	0° 6′	0° 5′	4′ 48″	4′ 22″	4′ 0″	3′ 41″	3′ 26″
88	0° 6′	0° 5′	0° 4′	0° 3′	0° 3′	0° 3′	2′ 24″	2′ 11″	2′ 0″	1′ 51″	1′ 43″

Table of Parallaxes of Altitude [TABULA PARALLAXIUM ALTITUDINIS.][238]

Degrees of apparent altitude	80	90	100	110	120	130	140	150	160	170	180
Horizon	42′ 59″	38′ 12″	34′ 23″	31′ 15″	28′ 39″	26′ 27″	24′ 33″	22′ 55″	21′ 29″	20′ 13″	19′ 6″
2	42′ 57″	38′ 10″	34′ 21″	31′ 14″	28′ 38″	26′ 26″	24′ 32″	22′ 54″	21′ 28″	20′ 13″	19′ 5″
4	42′ 52″	38′ 6″	34′ 18″	31′ 11″	28′ 35″	26′ 23″	24′ 30″	22′ 52″	21′ 26″	20′ 10″	19′ 3″
6	42′ 44″	38′ 0″	34′ 11″	31′ 5″	28′ 30″	26′ 18″	24′ 25″	22′ 48″	21′ 22″	20′ 7″	19′ 0″
8	42′ 33″	37′ 50″	34′ 3″	30′ 57″	28′ 22″	26′ 11″	24′ 19″	22′ 42″	21′ 17″	20′ 2″	18′ 55″
10	42′ 19″	37′ 37″	33′ 51″	30′ 47″	28′ 13″	26′ 3″	24′ 11″	22′ 34″	21′ 10″	19′ 55″	18′ 49″
12	42′ 2″	37′ 22″	33′ 38″	30′ 34″	28′ 1″	25′ 52″	24′ 1″	22′ 25″	21′ 1″	19′ 47″	18′ 41″
14	41′ 42″	37′ 4″	33′ 21″	30′ 19″	27′ 48″	25′ 40″	23′ 50″	22′ 14″	20′ 51″	19′ 37″	18′ 32″
16	41′ 18″	36′ 43″	33′ 3″	30′ 3″	27′ 32″	25′ 25″	23′ 36″	22′ 2″	20′ 39″	19′ 26″	18′ 22″
18	40′ 52″	36′ 20″	32′ 42″	29′ 43″	27′ 15″	25′ 9″	23′ 21″	21′ 48″	20′ 26″	19′ 14″	18′ 10″
20	40′ 13″	35′ 54″	32′ 18″	29′ 22″	26′ 55″	24′ 51″	23′ 4″	21′ 32″	20′ 11″	19′ 0″	17′ 57″
22	39′ 51″	35′ 25″	31′ 53″	28′ 59″	26′ 34″	24′ 31″	22′ 46″	21′ 15″	19′ 55″	18′ 45″	17′ 42″
24	39′ 15″	34′ 54″	31′ 24″	28′ 33″	26′ 10″	24′ 10″	22′ 26″	20′ 57″	19′ 38″	18′ 28″	17′ 27″
26	38′ 37″	34′ 20″	30′ 54″	28′ 5″	25′ 45″	23′ 46″	22′ 4″	20′ 36″	19′ 19″	18′ 11″	17′ 10″
28	37′ 57″	33′ 44″	30′ 21″	27′ 36″	25′ 18″	23′ 21″	21′ 41″	20′ 14″	18′ 58″	17′ 51″	16′ 52″

[238] the head of the table reads, as on the preceding pages, "At a distance from the centre of the Earth, in semidiameters of the Earth" [AD DISTANTIAM A TERRÆ CENTRO SEMIDIAMM. TERRÆ.], and the figures 80 to 180 heading the columns are those distances. Every column is headed "M. Se." and gives the parallax of altitude in minutes and seconds. The left column is headed "Degrees of apparent altitude" [Grad. Viſæ Altitud.]. The rows are printed in groups of three, divided by rules.

Degrees of apparent altitude	80	90	100	110	120	130	140	150	160	170	180
30	37′ 13″	33′ 5″	29′ 46″	27′ 4″	24′ 49″	22′ 54″	21′ 16″	19′ 51″	18′ 36″	17′ 31″	16′ 32″
32	36′ 27″	32′ 24″	29′ 9″	26′ 30″	24′ 18″	22′ 26″	20′ 49″	19′ 26″	18′ 13″	17′ 9″	16′ 12″
34	35′ 38″	31′ 40″	28′ 30″	25′ 55″	23′ 45″	21′ 55″	20′ 21″	19′ 0″	17′ 49″	16′ 46″	15′ 50″
36	34′ 46″	30′ 54″	27′ 49″	25′ 17″	23′ 11″	21′ 24″	19′ 52″	18′ 33″	17′ 23″	16′ 21″	15′ 27″
38	33′ 52″	30′ 6″	27′ 5″	24′ 38″	22′ 35″	20′ 50″	19′ 21″	18′ 4″	16′ 56″	15′ 56″	15′ 3″
40	32′ 55″	29′ 16″	26′ 20″	23′ 56″	21′ 57″	20′ 15″	18′ 49″	17′ 33″	16′ 28″	15′ 29″	14′ 38″
42	31′ 56″	28′ 23″	25′ 33″	23′ 13″	21′ 17″	19′ 39″	18′ 15″	17′ 2″	15′ 58″	15′ 2″	14′ 12″
44	30′ 55″	27′ 29″	24′ 44″	22′ 29″	20′ 36″	19′ 1″	17′ 40″	16′ 29″	15′ 27″	14′ 33″	13′ 44″
46	29′ 51″	26′ 32″	23′ 53″	21′ 43″	19′ 54″	18′ 22″	17′ 3″	15′ 55″	14′ 56″	14′ 3″	13′ 16″
48	28′ 45″	25′ 34″	23′ 0″	20′ 55″	19′ 10″	17′ 42″	16′ 26″	15′ 20″	14′ 23″	13′ 32″	12′ 47″
50	27′ 37″	24′ 33″	22′ 6″	20′ 5″	18′ 25″	17′ 0″	15′ 47″	14′ 44″	13′ 49″	13′ 0″	12′ 17″
52	26′ 27″	23′ 31″	21′ 10″	19′ 14″	17′ 38″	16′ 17″	15′ 7″	14′ 7″	13′ 14″	12′ 27″	11′ 45″
54	25′ 15″	22′ 27″	20′ 13″	18′ 22″	16′ 50″	15′ 33″	14′ 26″	13′ 28″	12′ 38″	11′ 53″	11′ 14″
56	24′ 2″	21′ 22″	19′ 13″	17′ 29″	16′ 1″	14′ 47″	13′ 44″	12′ 49″	12′ 1″	11′ 18″	10′ 41″
58	22′ 46″	20′ 15″	18′ 13″	16′ 34″	15′ 11″	14′ 1″	13′ 1″	12′ 9″	11′ 23″	10′ 43″	10′ 7″
60	21′ 29″	19′ 6″	17′ 11″	15′ 37″	14′ 20″	13′ 13″	12′ 17″	11′ 28″	10′ 45″	10′ 7″	9′ 33″
62	20′ 10″	17′ 56″	16′ 8″	14′ 40″	13′ 27″	12′ 25″	11′ 32″	10′ 46″	10′ 5″	9′ 30″	8′ 58″
64	18′ 50″	16′ 45″	15′ 4″	13′ 42″	12′ 34″	11′ 36″	10′ 46″	10′ 3″	9′ 25″	8′ 52″	8′ 22″
66	17′ 29″	15′ 32″	13′ 59″	12′ 43″	11′ 39″	10′ 45″	9′ 59″	9′ 19″	8′ 44″	8′ 13″	7′ 46″
68	16′ 6″	14′ 19″	12′ 53″	11′ 42″	10′ 44″	9′ 54″	9′ 12″	8′ 35″	8′ 3″	7′ 35″	7′ 9″
70	14′ 42″	13′ 4″	11′ 45″	10′ 41″	9′ 48″	9′ 3″	8′ 24″	7′ 50″	7′ 21″	6′ 55″	6′ 32″
72	13′ 17″	11′ 48″	10′ 37″	9′ 39″	8′ 51″	8′ 10″	7′ 35″	7′ 5″	6′ 38″	6′ 15″	5′ 54″
74	11′ 51″	10′ 32″	9′ 29″	8′ 37″	7′ 54″	7′ 17″	6′ 46″	6′ 19″	5′ 55″	5′ 34″	5′ 16″
76	10′ 24″	9′ 14″	8′ 19″	7′ 34″	6′ 56″	6′ 24″	5′ 56″	5′ 33″	5′ 12″	4′ 54″	4′ 37″
78	8′ 56″	7′ 57″	7′ 9″	6′ 30″	5′ 57″	5′ 30″	5′ 6″	4′ 46″	4′ 28″	4′ 12″	3′ 58″
80	7′ 28″	6′ 38″	5′ 58″	5′ 26″	4′ 58″	4′ 36″	4′ 16″	3′ 59″	3′ 44″	3′ 31″	3′ 19″
82	5′ 59″	5′ 19″	4′ 47″	4′ 21″	3′ 59″	3′ 41″	3′ 25″	3′ 11″	2′ 59″	2′ 49″	2′ 37″
84	4′ 30″	4′ 0″	3′ 36″	3′ 16″	3′ 0″	2′ 46″	2′ 34″	2′ 24″	2′ 15″	2′ 7″	2′ 0″
86	3′ 0″	2′ 40″	2′ 24″	2′ 11″	2′ 0″	1′ 51″	1′ 43″	1′ 36″	1′ 30″	1′ 25″	1′ 20″
88	1′ 30″	1′ 20″	1′ 12″	1′ 5″	1′ 0″	0′ 55″	0′ 52″	0′ 48″	0′ 45″	0′ 42″	0′ 40″

Table of Parallaxes of Altitude [TABULA PARALLAXIUM ALTITUDINIS·][239]

Degrees of apparent altitude	190	200	250	300	400	500	600	700	800	900	1000
Horizon	18′ 6″	17′ 12″	13′ 46″	11′ 28″	8′ 36″	6′ 53″	5′ 44″	4′ 55″	4′ 18″	3′ 49″	3′ 26″
2	18′ 5″	17′ 11″	13′ 45″	11′ 27″	8′ 35″	6′ 52″	5′ 44″	4′ 54″	4′ 18″	3′ 49″	3′ 26″
4	18′ 3″	17′ 9″	13′ 43″	11′ 26″	8′ 34″	6′ 52″	5′ 43″	4′ 54″	4′ 17″	3′ 49″	3′ 26″

[239] the head of the table reads, as on the preceding pages, "At a distance from the centre of the Earth, in semidiameters of the Earth" [AD DISTANTIAM A TERRÆ CENTRO SEMIDIAMM. TERRÆ.], and the figures 190 to 1000 heading the columns are those distances. Every column is headed for minutes and seconds (printed "M.Sec.", "Mi.Se." and "M.Sec") and gives the parallax of altitude in minutes and seconds. The left column is headed "Degrees of apparent altitude" [Grad. Viſæ Altitud.]. The rows are printed in groups of three, divided by rules.

Degrees of apparent altitude	190	200	250	300	400	500	600	700	800	900	1000
6	18′ 0″	17′ 6″	13′ 41″	11′ 24″	8′ 33″	6′ 50″	5′ 42″	4′ 53″	4′ 16″	3′ 48″	3′ 25″
8	17′ 55″	17′ 1″	13′ 37″	11′ 21″	8′ 31″	6′ 49″	5′ 40″	4′ 52″	4′ 15″	3′ 47″	3′ 24″
10	17′ 49″	16′ 56″	13′ 33″	11′ 17″	8′ 28″	6′ 46″	5′ 39″	4′ 50″	4′ 14″	3′ 46″	3′ 23″
12	17′ 42″	16′ 49″	13′ 27″	11′ 13″	8′ 24″	6′ 43″	5′ 36″	4′ 48″	4′ 12″	3′ 44″	3′ 22″
14	17′ 33″	16′ 41″	13′ 21″	11′ 7″	8′ 20″	6′ 40″	5′ 34″	4′ 46″	4′ 10″	3′ 42″	3′ 20″
16	17′ 24″	16′ 31″	13′ 13″	11′ 1″	8′ 16″	6′ 37″	5′ 30″	4′ 43″	4′ 8″	3′ 40″	3′ 18″
18	17′ 12″	16′ 21″	13′ 5″	10′ 54″	8′ 11″	6′ 32″	5′ 27″	4′ 40″	4′ 5″	3′ 38″	3′ 16″
20	17′ 0″	16′ 9″	12′ 55″	10′ 46″	8′ 5″	6′ 28″	5′ 23″	4′ 37″	4′ 2″	3′ 35″	3′ 14″
22	16′ 47″	15′ 56″	12′ 45″	10′ 37″	7′ 58″	6′ 22″	5′ 19″	4′ 33″	3′ 59″	3′ 32″	3′ 11″
24	16′ 32″	15′ 42″	12′ 34″	10′ 28″	7′ 51″	6′ 17″	5′ 14″	4′ 29″	3′ 56″	3′ 29″	3′ 8″
26	16′ 16″	15′ 27″	12′ 22″	10′ 18″	7′ 43″	6′ 11″	5′ 9″	4′ 25″	3′ 52″	3′ 26″	3′ 5″
28	15′ 59″	15′ 11″	12′ 8″	10′ 7″	7′ 35″	6′ 4″	5′ 4″	4′ 20″	3′ 48″	3′ 22″	3′ 2″
30	15′ 40″	14′ 53″	11′ 55″	9′ 55″	7′ 27″	5′ 57″	4′ 58″	4′ 15″	3′ 43″	3′ 18″	2′ 59″
32	15′ 21″	14′ 35″	11′ 40″	9′ 43″	7′ 17″	5′ 50″	4′ 52″	4′ 10″	3′ 39″	3′ 14″	2′ 55″
34	15′ 0″	14′ 15″	11′ 24″	9′ 30″	7′ 7″	5′ 42″	4′ 45″	4′ 4″	3′ 34″	3′ 10″	2′ 51″
36	14′ 38″	13′ 54″	11′ 8″	9′ 16″	6′ 57″	5′ 34″	4′ 38″	3′ 58″	3′ 29″	3′ 4″	2′ 47″
38	14′ 15″	13′ 33″	10′ 50″	9′ 2″	6′ 46″	5′ 25″	4′ 31″	3′ 52″	3′ 23″	3′ 1″	2′ 43″
40	13′ 52″	13′ 10″	10′ 32″	8′ 47″	6′ 35″	5′ 16″	4′ 23″	3′ 46″	3′ 18″	2′ 56″	2′ 38″
42	13′ 27″	12′ 46″	10′ 13″	8′ 31″	6′ 23″	5′ 7″	4′ 15″	3′ 39″	3′ 12″	2′ 50″	2′ 33″
44	13′ 1″	12′ 22″	9′ 53″	8′ 15″	6′ 11″	4′ 57″	4′ 7″	3′ 32″	3′ 5″	2′ 45″	2′ 28″
46	12′ 34″	11′ 56″	9′ 33″	7′ 58″	5′ 58″	4′ 46″	3′ 59″	3′ 25″	2′ 59″	2′ 39″	2′ 23″
48	12′ 6″	11′ 30″	9′ 12″	7′ 40″	5′ 45″	4′ 36″	3′ 50″	3′ 17″	2′ 52″	2′ 33″	2′ 18″
50	11′ 38″	11′ 3″	8′ 50″	7′ 22″	5′ 31″	4′ 25″	3′ 41″	3′ 9″	2′ 46″	2′ 27″	2′ 13″
52	11′ 8″	10′ 35″	8′ 28″	7′ 3″	5′ 17″	4′ 14″	3′ 32″	3′ 1″	2′ 39″	2′ 21″	2′ 7″
54	10′ 38″	10′ 6″	8′ 5″	6′ 44″	5′ 3″	4′ 3″	3′ 22″	2′ 53″	2′ 31″	2′ 13″	2′ 2″
56	10′ 7″	9′ 37″	7′ 41″	6′ 24″	4′ 48″	3′ 51″	3′ 12″	2′ 45″	2′ 24″	2′ 8″	1′ 55″
58	9′ 35″	9′ 7″	7′ 17″	6′ 4″	4′ 33″	3′ 39″	3′ 2″	2′ 36″	2′ 17″	2′ 1″	1′ 49″
60	9′ 3″	8′ 36″	6′ 53″	5′ 44″	4′ 18″	3′ 27″	2′ 52″	2′ 27″	2′ 9″	1′ 55″	1′ 43″
62	8′ 30″	8′ 4″	6′ 27″	5′ 23″	4′ 2″	3′ 14″	2′ 41″	2′ 18″	2′ 1″	1′ 48″	1′ 37″
64	7′ 56″	7′ 32″	6′ 2″	5′ 1″	3′ 46″	3′ 1″	2′ 31″	2′ 9″	1′ 53″	1′ 40″	1′ 30″
66	7′ 22″	7′ 0″	5′ 36″	4′ 40″	3′ 30″	2′ 48″	2′ 22″	2′ 0″	1′ 45″	1′ 33″	1′ 24″
68	6′ 47″	6′ 26″	5′ 9″	4′ 18″	3′ 13″	2′ 35″	2′ 9″	1′ 50″	1′ 37″	1′ 26″	1′ 17″
70	6′ 11″	5′ 53″	4′ 42″	3′ 55″	2′ 56″	2′ 21″	1′ 58″	1′ 41″	1′ 28″	1′ 18″	1′ 11″
72	5′ 35″	5′ 19″	4′ 15″	3′ 32″	2′ 39″	2′ 7″	1′ 46″	1′ 31″	1′ 20″	1′ 11″	1′ 4″
74	4′ 59″	4′ 44″	3′ 47″	3′ 10″	2′ 22″	1′ 54″	1′ 35″	1′ 21″	1′ 11″	1′ 3″	0′ 57″
76	4′ 23″	4′ 9″	3′ 20″	2′ 46″	2′ 5″	1′ 40″	1′ 23″	1′ 11″	1′ 2″	0′ 55″	0′ 50″
78	3′ 46″	3′ 34″	2′ 52″	2′ 23″	1′ 48″	1′ 26″	1′ 11″	1′ 1″	0′ 54″	0′ 48″	0′ 43″
80	3′ 9″	2′ 59″	2′ 23″	1′ 59″	1′ 30″	1′ 12″	1′ 0″	0′ 51″	0′ 45″	0′ 40″	0′ 36″
82	2′ 31″	2′ 24″	1′ 55″	1′ 36″	1′ 12″	0′ 57″	0′ 48″	0′ 41″	0′ 36″	0′ 32″	0′ 29″
84	1′ 53″	1′ 48″	1′ 26″	1′ 12″	0′ 54″	0′ 43″	0′ 36″	0′ 31″	0′ 27″	0′ 24″	0′ 21″
86	1′ 16″	1′ 12″	0′ 58″	0′ 48″	0′ 36″	0′ 29″	0′ 24″	0′ 21″	0′ 18″	0′ 16″	0′ 14″
88	0′ 38″	0′ 36″	0′ 29″	0′ 24″	0′ 18″	0′ 14″	0′ 12″	0′ 10″	0′ 9″	0′ 8″	0′ 7″

Table of Parallaxes of Altitude [TABULA PARALLAXIUM ALTITUDINIS.][240]

Degrees of apparent altitude	1100	1200	1300	1400	1500	2000	2500	3000	3500	4000	5000	6000	7000	8000	9000	10000
Horizon	3′ 7″	2′ 52″	2′ 38″	2′ 27″	2′ 17″	1′ 43″	1′ 22″	1′ 9″	59″	52″	41″	34″	29″	26″	23″	21″
2	3′ 7″	2′ 52″	2′ 38″	2′ 27″	2′ 17″	1′ 43″	1′ 22″	1′ 9″	59″	52″	41″	34″	29″	26″	23″	21″
4	3′ 7″	2′ 51″	2′ 38″	2′ 27″	2′ 17″	1′ 43″	1′ 22″	1′ 9″	59″	52″	41″	34″	29″	26″	23″	21″
6	3′ 6″	2′ 51″	2′ 38″	2′ 27″	2′ 17″	1′ 43″	1′ 22″	1′ 8″	59″	51″	41″	34″	29″	26″	23″	21″
8	3′ 6″	2′ 50″	2′ 37″	2′ 26″	2′ 16″	1′ 42″	1′ 22″	1′ 8″	58″	51″	41″	34″	29″	26″	23″	20″
10	3′ 5″	2′ 49″	2′ 36″	2′ 25″	2′ 15″	1′ 42″	1′ 21″	1′ 8″	58″	51″	41″	34″	29″	25″	23″	20″
12	3′ 3″	2′ 48″	2′ 35″	2′ 24″	2′ 15″	1′ 41″	1′ 21″	1′ 7″	58″	50″	40″	34″	29″	25″	22″	20″
14	3′ 2″	2′ 47″	2′ 34″	2′ 23″	2′ 13″	1′ 40″	1′ 20″	1′ 7″	57″	50″	40″	33″	29″	25″	22″	20″
16	3′ 0″	2′ 45″	2′ 33″	2′ 22″	2′ 12″	1′ 39″	1′ 19″	1′ 6″	57″	50″	40″	33″	28″	25″	22″	20″
18	2′ 58″	2′ 43″	2′ 31″	2′ 20″	2′ 11″	1′ 38″	1′ 18″	1′ 5″	56″	49″	39″	33″	28″	25″	22″	20″
20	2′ 56″	2′ 41″	2′ 29″	2′ 18″	2′ 9″	1′ 37″	1′ 18″	1′ 5″	55″	48″	39″	32″	28″	24″	22″	19″
22	2′ 54″	2′ 39″	2′ 27″	2′ 17″	2′ 7″	1′ 36″	1′ 17″	1′ 4″	55″	48″	38″	32″	27″	24″	21″	19″
24	2′ 51″	2′ 37″	2′ 25″	2′ 15″	2′ 6″	1′ 34″	1′ 15″	1′ 3″	54″	47″	38″	32″	27″	24″	21″	19″
26	2′ 49″	2′ 34″	2′ 23″	2′ 12″	2′ 4″	1′ 33″	1′ 14″	1′ 2″	53″	46″	37″	31″	26″	23″	21″	19″
28	2′ 46″	2′ 32″	2′ 20″	2′ 10″	2′ 1″	1′ 31″	1′ 13″	1′ 1″	52″	46″	36″	30″	26″	23″	20″	18″
30	2′ 42″	2′ 29″	2′ 17″	2′ 8″	1′ 59″	1′ 29″	1′ 11″	1′ 0″	51″	45″	36″	30″	25″	22″	20″	18″
32	2′ 39″	2′ 26″	2′ 15″	2′ 5″	1′ 57″	1′ 27″	1′ 10″	0′ 58″	50″	44″	35″	29″	25″	22″	19″	1[?]″
34	2′ 35″	2′ 23″	2′ 12″	2′ 2″	1′ 54″	1′ 26″	1′ 8″	0′ 57″	49″	43″	34″	29″	24″	21″	19″	17″
36	2′ 32″	2′ 19″	2′ 8″	1′ 59″	1′ 51″	1′ 23″	1′ 7″	0′ 56″	48″	42″	33″	28″	24″	21″	19″	17″
38	2′ 28″	2′ 15″	2′ 5″	1′ 56″	1′ 48″	1′ 21″	1′ 5″	0′ 54″	46″	41″	33″	27″	23″	20″	18″	16″
40	2′ 24″	2′ 12″	2′ 2″	1′ 53″	1′ 45″	1′ 19″	1′ 3″	0′ 53″	45″	40″	32″	26″	23″	20″	18″	16″
42	2′ 19″	2′ 8″	1′ 58″	1′ 49″	1′ 42″	1′ 17″	1′ 1″	0′ 51″	44″	38″	31″	26″	22″	19″	17″	15″
44	2′ 15″	2′ 4″	1′ 54″	1′ 46″	1′ 39″	1′ 14″	0′ 59″	0′ 49″	42″	37″	30″	25″	21″	19″	16″	15″
46	2′ 10″	1′ 59″	1′ 50″	1′ 42″	1′ 36″	1′ 12″	0′ 57″	0′ 48″	41″	36″	29″	24″	20″	18″	16″	14″
48	2′ 5″	1′ 55″	1′ 46″	1′ 39″	1′ 32″	1′ 9″	0′ 55″	0′ 46″	39″	35″	28″	23″	20″	17″	15″	14″
50	2′ 1″	1′ 50″	1′ 42″	1′ 35″	1′ 28″	1′ 6″	0′ 53″	0′ 44″	38″	33″	27″	22″	19″	17″	15″	13″
52	1′ 55″	1′ 46″	1′ 38″	1′ 31″	1′ 25″	1′ 3″	0′ 51″	0′ 42″	36″	32″	25″	21″	18″	16″	14″	13″
54	1′ 50″	1′ 41″	1′ 33″	1′ 27″	1′ 21″	1′ 1″	0′ 49″	0′ 40″	35″	30″	24″	20″	17″	15″	13″	12″
56	1′ 45″	1′ 36″	1′ 29″	1′ 22″	1′ 17″	0′ 58″	0′ 46″	0′ 38″	33″	29″	23″	19″	16″	14″	13″	12″
58	1′ 39″	1′ 31″	1′ 24″	1′ 18″	1′ 12″	0′ 55″	0′ 44″	0′ 36″	31″	27″	22″	18″	16″	14″	12″	11″
60	1′ 34″	1′ 26″	1′ 19″	1′ 14″	1′ 9″	0′ 52″	0′ 41″	0′ 34″	29″	26″	21″	17″	15″	13″	11″	10″
62	1′ 28″	1′ 21″	1′ 14″	1′ 9″	1′ 5″	0′ 48″	0′ 39″	0′ 32″	28″	24″	19″	16″	14″	12″	11″	10″
64	1′ 22″	1′ 15″	1′ 10″	1′ 5″	1′ 0″	0′ 45″	0′ 36″	0′ 30″	26″	23″	18″	15″	13″	11″	10″	9″
66	1′ 16″	1′ 10″	1′ 5″	1′ 0″	0′ 56″	0′ 42″	0′ 34″	0′ 28″	24″	21″	17″	14″	12″	10″	10″	8″
68	1′ 10″	1′ 4″	0′ 59″	0′ 55″	0′ 52″	0′ 39″	0′ 31″	0′ 26″	22″	19″	15″	13″	11″	10″	9″	8″

[240] the head of the table reads, as on the preceding pages, "At a distance from the centre of the Earth, in semidiameters of the Earth" [AD DISTANTIAM A TERRÆ CENTRO SEMIDIAMM. TERRÆ.], and the figures 1100 to 10000 heading the columns are those distances. The eight columns 1100 to 3000 are headed "M. Se." and give the parallax of altitude in minutes and seconds; the eight narrow columns 3500 to 10000, whose distances are printed turned sideways, are headed "Se." and give it in seconds only. The left column is headed "Degrees of apparent altitude" [Grad. Viſæ Altitud.]. The rows are printed in groups of three, divided by rules. At altitude 88 the 1300 column prints no minute figure.

Degrees of apparent altitude	1100	1200	1300	1400	1500	2000	2500	3000	3500	4000	5000	6000	7000	8000	9000	10000
70	1′ 4″	0′ 59″	0′ 54″	0′ 50″	0′ 47″	0′ 35″	0′ 28″	0′ 24″	20″	18″	14″	12″	10″	9″	8″	7″
72	0′ 58″	0′ 53″	0′ 49″	0′ 46″	0′ 42″	0′ 32″	0′ 26″	0′ 21″	18″	16″	13″	11″	9″	8″	7″	6″
74	0′ 52″	0′ 47″	0′ 44″	0′ 41″	0′ 38″	0′ 28″	0′ 23″	0′ 19″	16″	14″	11″	10″	8″	7″	6″	6″
76	0′ 45″	0′ 42″	0′ 38″	0′ 36″	0′ 33″	0′ 25″	0′ 20″	0′ 17″	14″	12″	10″	8″	7″	6″	6″	5″
78	0′ 39″	0′ 36″	0′ 33″	0′ 31″	0′ 29″	0′ 21″	0′ 17″	0′ 14″	12″	12″	9″	7″	6″	5″	5″	4″
80	0′ 33″	0′ 30″	0′ 28″	0′ 26″	0′ 24″	0′ 18″	0′ 14″	0′ 12″	10″	9″	7″	6″	5″	5″	4″	4″
82	0′ 26″	0′ 24″	0′ 22″	0′ 21″	0′ 19″	0′ 14″	0′ 11″	0′ 10″	8″	7″	6″	5″	4″	4″	3″	3″
84	0′ 20″	0′ 18″	0′ 17″	0′ 15″	0′ 14″	0′ 11″	0′ 9″	0′ 7″	6″	5″	4″	4″	3″	3″	2″	2″
86	0′ 13″	0′ 12″	0′ 11″	0′ 10″	0′ 10″	0′ 7″	0′ 6″	0′ 5″	4″	4″	3″	2″	2″	2″	2″	2″
88	0′ 7″	0′ 6″	6″	0′ 5″	0′ 5″	0′ 4″	0′ 3″	0′ 2″	2″	2″	2″	1″	1″	0″	0″	0″

Table of Parallaxes of Altitude at a distance of the phenomenon from the Earth's surface of 20 German miles [Tabula Parallaxium Altitudinis ad diſtantiam Phænomeni à Superficie terrena 20 mill.germ.][241]

Apparent altitude	Parallax	Apparent altitude	Parallax
Horizon	77° 46′	46	42° 45′
3	77° 24′	47	41° 48′
4	77° 8′	48	40° 50′
5	76° 48′	49	39° 52′
6	76° 23′	50	38° 55′
7	75° 56′	51	37° 57′
8	75° 24′	52	36° 59′
9	74° 51′	53	36° 1′
10	74° 14′	54	35° 3′
11	73° 36′	55	34° 5′
12	72° 55′	56	33° 7′
13	72° 13′	57	32° 9′
14	71° 29′	58	31° 11′
15	70° 43′	59	30° 13′
16	69° 57′	60	29° 15′
17	69° 9′	61	28° 17′
18	68° 21′	62	27° 19′
19	67° 31′	63	26° 20′
20	66° 41′	64	25° 22′
21	65° 50′	65	24° 24′
22	65° 2′	66	23° 25′
23	64° 6′	67	22° 27′
24	63° 13′	68	21° 29′
25	62° 20′	69	20° 30′

[241] the table stands at the right of the first paragraphs. It is set in two blocks side by side, divided by a double rule; in each, the column headed "Apparent altitude" [Viſæ Altit.] gives the altitude in degrees, and the column headed "Parallax, degrees and minutes" [Parall. Gr.M.] gives the parallax. The left block passes from the horizon directly to 3°: no rows for 1° and 2° are printed. The rows are printed in groups of three, divided by rules.

Apparent altitude	Parallax	Apparent altitude	Parallax
26	61° 27′	70	19° 32′
27	60° 33′	71	18° 33′
28	59° 38′	72	17° 35′
29	58° 44′	73	16° 36′
30	57° 49′	74	15° 37′
31	56° 45′	75	14° 39′
32	55° 58′	76	13° 40′
33	55° 3′	77	12° 42′
34	54° 7′	78	11° 43′
35	53° 11′	79	10° 45′
36	52° 15′	80	9° 46′
37	51° 18′	81	8° 48′
38	50° 22′	82	7° 49′
39	49° 25′	83	6° 50′
40	48° 28′	84	5° 52′
41	47° 32′	85	4° 53′
42	46° 34′	86	3° 54′
43	45° 37′	87	2° 56′
44	44° 40′	88	1° 57′
45	43° 43′	89	0° 58′

[Margin: Hac in diſtantiâ Cometa locum in horam mutaſſet.] *At this distance the comet would have changed its place hour by hour.*

1. Let there be, then, in the accompanying diagram B: *a*, the following star of Perseus's left foot; *b*, the heel; *c*, the comet; *e*, the place of the comet if it had lacked its proper motion; while *f* is the place of the comet that it acquired by its proper motion, to the left. This was the first observation, with the heel at an altitude of 22°, at about 5 in the evening, in the eastern quadrant, when the comet first came into view after sunset on December 26 and formed an entirely straight line with the two in Perseus's foot. Now, to an altitude of 22° and a distance of 20 miles there corresponds, from the accompanying parallactic table, a horizontal parallax of 65°. The true place of the comet at that time was therefore in reality higher by that many degrees, namely at *c*; for all parallax depresses, and the more so, the lower the altitude of the phenomenon.
2. In the second observation, with the heel at an altitude of 30°, at about 6 o'clock, the comet's parallax *f c* comes to 58°. Since this is 7° less than the former, the comet in this station also comes out higher, so that it now forms an acute-angled scalene triangle with the said stars, where an hour before it had formed an entirely straight line.

[Margin: Quanto intervallo Cometa remotus extitiſſet à calcaneo hor. ſeptimâ.] *How great an interval separated the comet from the heel at the seventh hour.*

3. In the third observation, at 7 in the evening, with an altitude of 40°[242] and a parallax of 48°, the triangle appears still more acute; at the same

[242] the degree mark is printed as a small superior sort shaped like a 6

time the distance from the heel is thirteen times greater than in the first observation, and consequently the comet itself is rendered higher by 26°.

[Margin: Ad 40 grad. diſtantia dicta crevisſet, in remotioneCometæ à terra 20 mill: hor. circ. 10] *The said distance would have grown to 40 degrees, at the comet's distance of 20 miles from the Earth, at about 10 o'clock.*

4. In the following observation, with an altitude of 50° and a parallax of 39°; likewise in the fifth observation, with an altitude of 60° and a parallax of 29°; and also in the sixth observation, with an altitude of 64°, that is, on the meridian itself, and a parallax of 25½° — as the altitude increased and the parallax decreased, the triangle became ever more acute, and the distance of the comet from the heel greater. Thus in the said sixth observation, that is, at the greatest elevation, the comet was already 40 degrees away from the heel (whereas in the first observation, at 5 o'clock, it was not yet two degrees distant), and stood some degrees beyond the zenith towards the north, although those two little stars in fact appeared some 20 degrees below the zenith.

[Margin: Quâ ratione vicisſim diſtantia Cometæ à Calcaneo decrevisſet.] *How, in turn, the distance of the comet from the heel decreased.*

5. From this sixth observation, that is, from the greatest altitude of the heel, as the altitudes in the western quadrant decrease in turn in the same proportion, the parallaxes grow again. From here up to the 4th hour of the morning, namely the 10th observation, the triangles again become gradually shorter, and in part more obtuse, and the distances of the comet from the heel diminish: exactly the contrary of what happened in the eastern quadrant from the second observation to the sixth.

[Margin: Inſolens Cometæ phænomenon.] *An unusual phenomenon of the comet.*

6. In the eleventh observation, however, at 5 in the morning, with the heel at an altitude of only 20 degrees, a quite different and notable change is found. For since the parallax there is two degrees greater than in the first observation, the triangle, which until now had appeared upward together with the comet, is now seen turned downward, and its apex reaches as many degrees below the straight line *a b d* as the parallax of this eleventh observation is greater than the parallax of that first observation. So that in the space of a single hour the comet, with the two stars so often mentioned, now an upright acute-angled triangle, now in turn, out of a triangle, a line quite

Diagram. Engraved plate, "Fig. B", showing the comet against the two stars in Perseus's foot at twelve successive observations through one night, set as twelve columns side by side, divided by dotted verticals. In each column the two stars (drawn as asterisks) stand at the foot and the comet (a hatched disc, lettered *c*) above or below them, joined to each star by a straight line. A solid horizontal line runs across the head of the plate, with an *e* on each column's dotted vertical just below it and an *f* above a dotted line just over it (column

1 has an *e* but no *f*). Up each column, set sideways, is the parallax for that observation, and beside each comet its altitude; below the columns stand the hour and the number of the observation. In column 1 the comet stands at the foot, in line with the two stars; from column 2 to column 6 it rises higher and the triangle grows more acute; from column 7 to column 10 it comes down again; in columns 11 and 12 it stands below the two stars, the triangle pointing downward. Every label on the plate was read; none is supplied from the text.

- Column 1: *e*; "Parall. 65°." *Parallax 65°*; "Altit. 22°." *altitude 22°*, *c*; *a*, *b* (no *d*); "Hor. 5." *5 o'clock*; "1."
- Column 2: *f*, *e*; "Parall. 58°."; "Altit. 30°.", *c*; *a*, *b*, *d*; "Hor. 6."; "2."
- Column 3: *f*, *e*; "Parall. 48°."; "Altit. 48°.", *c*; *a*, *b*, *d*; "Hor. 7."; "3."[243]
- Column 4: *f*, *e*; "Parall. 39°."; "Altit. 50°.", *c*; stars unlettered; "Hor. 8."; "4."
- Column 5: *f*, *e*; "Parall. 29°."; "Altit. 60°.", *c*; stars unlettered; "Hor. 9."; "5."
- Column 6: *f*, *e*; "Parall. 25½°."; "Altit. 64°.", *c*; *a*, *b*, *d*; "Hor. 10."; "6."
- Column 7: *f*, *e*; "Parall. 29." (no degree mark); "Altit. 60°.", *c*; *a*, *b*, *d*; "Hor. 12."; "7."
- Column 8: *f*, *e*; "Parall. 39°."; *altitude 50° 50′*, *c*; stars unlettered; "Hor. 1½."; "8."[244]
- Column 9: *f*, *e*; "Parall. 48°."; "Altit. 40°.", *c*; stars unlettered; "Hor. 2½."; "9."
- Column 10: *f*, *e*; "Parall. 58°."; "Altitudo 30°." *altitude 30°*, *c*; *a*, *b*, *d*; "Hor. 4."; "10."
- Column 11: *f*, *e*; "Parallaxis 67°." *parallax 67°*; "Altitud. 20°.", *c* (below the stars); *a*, *b* (above the stars), *d*; "Hor. 5."; "11."
- Column 12: *f*, *e*; "Parallaxis. 74°."; "Alt. 11°." *altitude 11°*, *c* (below the stars); *a*, *b* (above the stars), *d*; "Hor. 6."; "12."
- Below columns 2–3: "Ortus." *Rising.*
- Across columns 4–5, above the hours: "Temp. Veſpertino." *Evening time.*
- Across columns 9–10, above the hours: "Temp. matutino." *Morning time.*
- Below column 6: "Fig. B"
- Below columns 10–11: "Occaſus." *Setting.*
- Lower right corner: "Autor ſculps." *The author engraved it.*

straight, and now also, at once, out of the straight line, a somewhat less obtuse-angled inverted triangle, would form.

7. This can likewise be seen in the twelfth and last observation, at 6 in the morning (in which the parallax for the altitude of the heel is given by the table of parallaxes as 74°), except that here the comet makes still further towards the horizon, descends below the straight line *d b a*, namely by nine degrees, and again forms a more acute and much longer triangle.

[243] the plate gives the altitude here as 48°; the text, p. 192, gives 40° for the third observation, with a parallax of 48°.

[244] the point after "Altit" may be a colon.

[Margin: Qualis admiranda Cometæ ad 20 mill. remoti extitisſet apparitio.] *What a marvellous appearance the comet would have made, removed to 20 miles.*

[Margin: Diverſitas adſpectus ratione latitudinis & declinationis.] *The parallax with respect to latitude and declination.*

You see, then, from this sketch of the parallaxes for the various altitudes of the heel, or of the comet, in how many different ways the phenomenon would have changed its place from its rising to its setting, even if it had been 20 miles distant from the Earth and higher than the very matter of the twilights. Not only would it have left that line with the two said stars as quickly as possible; it would also have formed by far the most varied triangles, both upright and inverted, now acute-angled, now obtuse-angled. Moreover, it would have shown far more widely differing distances with respect to those stars, variable from minute to minute by almost a whole minute, as is clear from the parallactic table, and sometimes 40 degrees greater than it in fact had. From this it necessarily follows that the latitudes and declinations too (to say nothing of the longitudes and right ascensions, so as to avoid greater confusion) would have been increased and diminished in a remarkable way in that same night — and indeed by as much as 48½ degrees, since the difference between the greatest parallax, namely 74°, and the least, 25½°, equals exactly that many degrees. But to put it more clearly: even though in the first observation, at 5 o'clock, with the heel at an altitude of 22°, the latitude was in reality only 12° 46′, nevertheless after five hours had passed, at about 10 in the evening and the meridian, the latitude would by reason of the parallax have appeared as 54°. Likewise the declination, which was then only 31° 19′, would in a like space of time have grown to 73°. Furthermore, from the sixth observation to the 12th, that is, after 8 hours had passed, in the western quadrant, the latitudes and declinations would in turn have decreased by fully 48½. So at every minute of time, indeed at every moment, the said latitudes and declinations would have been highly variable — especially if those skilled in these matters had happened to observe the comet with instruments at the time. Indeed, why instruments? This sudden variation and change could have been noticed with the naked eye by anyone at all, even those wholly unlettered, provided they knew one or two little stars.

[Margin: Solido argumento demonſtratur Cometam ann. 1652 in æthere extitiſſe.] *It is shown by a solid argument that the comet of the year 1652 was in the aether.*

If, therefore, our comet had been in the highest region of the air, even at a distance of 20 German miles (to which not even the thinnest exhalations of all can ascend, still less those denser ones from which, according to the opinion of the Peripatetics [Peripati], comets are generated), it would certainly have produced parallaxes as monstrous and dreadful as we have said and demonstrated, and with them unheard-of and incredible variations, both of the said triangle of the comet with those two stars in the foot of Perseus and of the latitudes and declinations, continually from its rising to its setting. In fact, however, since it can be clearly demonstrated by all our observations, and indeed by

those of all others taken in any place whatever, that on December 26 the comet had none of these diversities and sudden changes at all, but through the whole night (as we have already indicated above more than once) almost a straight line with those two little stars it constantly kept, and that it varied its distance from the little stars just mentioned very little indeed, by no more than 1½ degrees, upward in accordance with its proper motion; and likewise that its latitudes and declinations increased continuously and proportionally by only two degrees — then it is certainly proved from this, and quite rightly, that the comet was not in the air, within whose bounds, by the admission of the natural philosophers [Phyſicorum], all those evaporations are contained, but much higher, and indeed, as will become still clearer from what is to be said below, in the aether itself.

[Margin: Rationi prorsùs abſonum eſt, ullum unquamCometam adeò horribiles ſaltus, ratione longitudinis & Aſcenſ. R. exercuiſſe.] *It is wholly contrary to reason that any comet ever made such dreadful leaps in longitude and right ascension.*

And so we have not the least doubt that from what has just been said it will have been shown amply, and more than enough, to everyone — especially to anyone weighing the matter a little more carefully — that in no way did either our comet, or any other comets ever, shine forth that made such wondrous leaps and led such utterly monstrous dances. Nevertheless, so that the mask may be stripped more and more from the Aristotelian philosophy and the truth be revealed more fully, I shall demonstrate what further, utterly absurd changes and parallaxes the comet would have shown at a distance of 20 miles from the Earth; how it would likewise have made its longitudes and right ascensions not only continually variable in a certain fixed manner, but now greater, now smaller; and how on each night it would have shown itself direct, stationary and retrograde, and then would have spun round continually at very great speed. As a result its distances from the fixed stars would have changed more and more. What is more, the comet would every night have joined itself to quite different fixed stars, far apart from one another both in longitude and in latitude. This is clearly found from the globe itself, if you correctly mark on it only the comet's hourly vertical parallaxes from the preceding diagram B, and so duly measure the longitudes, the latitudes and its various approaches to the fixed stars. For then you will notice that the parallaxes always extend in the vertical circle, according to its azimuth, towards the opposite side, that is, towards the point opposite the azimuth. For example: in the first observation, when the comet's vertical circle stood roughly in the east, that is, at about the 90th degree of azimuth counted from the meridian, the parallax tends towards the west. In the third, fourth and fifth observations, however, with the azimuth slightly changed, the parallax, in the vertical circle itself, now more southerly, became a little more northerly than the west; so that in the sixth observation, with the comet on the meridian itself, the parallax was entirely northern. But as the comet, with its azimuth, withdrew more and more from the meridian towards the west, the parallax gradually became more easterly; finally, in the

tenth, eleventh and twelfth observations, with the comet wholly in the west, the parallax faced entirely to the east. But all this will be perceived more openly and clearly from the accompanying figure, drawn in that manner from an artificial globe. This very thing could indeed also have been computed and demonstrated without difficulty, in various ways, by geometrical calculation; but we shall dispense with that labour on this occasion. For these parallaxes and differences of the anomalies do not amount to a few minutes and degrees but run to some tens of degrees, so that there is no need for such precision and care.

In this diagram, then, ♈ ♋ the ecliptic; *c c c c* etc. the apparent place of the comet in those twelve observations, distinguished by numbers; those lines hidden, running from *c* towards the ecliptic, give the apparent latitudes of the comet that the comet showed in each observation and at each altitude by reason of the parallax.

Diagram. An engraved figure set into the text, the figure drawn from an artificial globe that p. 196 announces: the comet's apparent places over the night against the stars, with the ecliptic as a straight line across the foot, Cancer's sign ♋ at its left (east) end and Aries's sign ♈ at its right (west) end. A dotted arc carries the comet's hatched discs, eleven of them numbered 2 to 12 and one unnumbered, standing just above and to the left of 11. From each disc a dotted vertical falls to the ecliptic; each is labelled sideways with a latitude and ends at a point marked with a longitude. Stars are drawn as asterisks, some named and about a dozen unnamed. Every label on the figure is listed below as read; none is supplied from the text. Constrained readings: "Caput Eric[[h/k]]tonii.", "Lucid. in de[[x/c]]t. pede", "H[[æ/œ]]di.", "Occidens[[./:]]" and the right-hand longitude "1[[8/♉]]".

- Comet discs: "c", "6"; "c", "5"; "c", "7"; "4", "c"; "8", "c"; "3", "c"; "9", "c"; "2", "c"; "10", "c"; "c" (unnumbered); "11", "c"; "12" (no *c*).
- Star labels: "In crure Casſiop." *in the leg of Cassiopeia*; "In flexura ad Coxas" *in the bend at the hips*; "Caput Eric[[h/k]]tonii." *the head of Erichthonius* [?]; "Extrema in Sup. ped. A." *the outermost in the upper foot of A.* (A. unexpanded); "Lucid. in de[[x/c]]t. pede" *the bright one in the right* [?] *foot*; "Alamac." *Alamak*; "Capella." *Capella*; "H[[æ/œ]]di." *the Kids*; "In crure Persei." *in the leg of Perseus*; "Calcan." *the heel*; "In pede Per." *in the foot of Perseus*; "Cauda" *the tail*.
- Latitudes, set sideways along the dotted verticals: "Latitud. 52°."; "Latitud. 48½°."; "Latitud. 28°."; "Latitud. 37°."; "Latit. 19°."; "Latit. 38°."; "Latit. 27°."; "Lat. 20½°."; "Lat. 15½°."; "Lat. 13°."; "Lat. 12°."; "6°." *latitude 52°, 48½°, 28°, 37°, 19°, 38°, 27°, 20½°, 15½°, 13°, 12°, 6°*.
- On the ecliptic, left to right: "Ecliptica." *the ecliptic*; "♋"; "Oriens." *east*; "24 ♊"; "18 ♊"; "12 ♊"; "2 ♊"; "25 ♉"; "23"; "21 ♉"; "20 ♉"; "16"; "15"; "13 ♉"; "Ecliptica:" *the ecliptic*; "Occidens[[./:]]" *west*; "1[[8/♉]]"; "♈" — *24° Gemini, 18° Gemini, 12° Gemini, 2° Gemini, 25° Taurus, 23, 21° Taurus, 20°*

Taurus, 16, 15, 13° Taurus; the last figure is 18, or 1 with the sign of Taurus [?].

- Below the ecliptic: "Cometæ" and "Longitudo." *longitude of the comet*; at the lower right, "Aut. Sculpsit." *the author engraved it*.

The points, however, at which those latitudes end on the Sun's path show the comet's apparent place in the ecliptic by longitude, both for each observation of that night of December 26 and for the altitudes of the comet given above. The comet's altitude in the first observation is 22 degrees; in the second, 30 degrees; in the third, 40 degrees; and so on.

[Margin: Cometa in diſtantiâ 20 mill. aliquot horarum ſpatio conſpicitur Retrogradus, Stationarius & directus, & quidem confuſo ordine.] *A comet at a distance of 20 miles is seen, within the space of a few hours, retrograde, stationary and direct, and in confused order at that.*

So anyone now examining the whole drawing carefully will see plainly that the comet, at that distance of 20 miles, from the first observation, taken at about 5 in the evening at an altitude of 22°, when it formed a straight line with the two in the foot of Perseus, became retrograde, and its longitude increased just as its latitude, on the contrary, decreased; so that around the fourth observation it would have appeared as if stationary. From this 4th observation, in turn, it would have become direct, advancing in the order of the signs, its latitude gradually increasing up to the sixth observation and its longitude all the way to the seventh. Then, having made its station, the latitudes would have diminished and the longitudes increased continuously, the comet being retrograde in its turn. And from this it is rightly concluded that the comet, on the same night, from 5 in the evening to 6 in the morning, would have been twice retrograde, twice stationary and once direct, and at the same time would have described a pseudo-circle [pſeudo-circulum] about 33 degrees in diameter and about 104 degrees in circumference — if, that is, it had had its seat in the aerial region, even placed in its highest part, at 20 miles. What is more, within the space of thirteen hours the comet would have varied its latitudes by as much as 40 degrees and likewise its longitudes by as much as 41 degrees (granting, too, that it could have stayed above the horizon so long, although this will be wholly denied a little later), now in the order of the signs, now against it, and no less wonderfully its distances from the heel, as is plain to anyone from the table below. The first column gives the individual observations; the second, the time of the observation; the third, the altitudes of the heel; the fourth, the comet's longitudes; the fifth, the comet's latitudes; and the sixth shows the comet's distance from the heel.

[Margin: Quomodo Cometa eâdem nocte bis retrogradus & Stationarius factus eſſet, ſi in ſupremâ aëris regione extitiſſet.] *How the comet would have become twice retrograde and stationary in the same night, if it had been in the highest region of the air.*

[Margin: Hoc in ſitu Cometa breviſſimo temporis intervallo longitudines & latitudines ad 40 grad. variat.] *In this position the comet varies its longitudes and latitudes by as much as 40 degrees within a very short interval of time.*

Obser-vation	Evening hour	Altitude of the heel	Longitude of the comet	Latitude of the comet	Distance of the comet from the heel
1	5 *veſp.*	22° 0′	25° ♉	13° *Boreal.*	2° *Circ.*
2	6	30° 0′	21° ♉ *Retrog.*	19° *B*	7°
3	7	40° 0′	16° ♉	28° *B*	17°
4	8	50° 0′	13° ♉ *Station.*	37° *B*	26½°
5	9	60° 0′	20° ♉	48½° *B*	36°
6	10	64° 0′	12° ♊	52° *B*	41°
7	12	60° 0′	24° ♊ *Direct.*	38° *B*	36½°
8	1½ *mat.*	50° 0′	18° ♊	27° *B*	27°
9	2½	40° 0′	12° ♊ *Station.*	20½° *B*	17½°
10	4	30° 0′	2° ♊	15½° *B*	7½°
11	5	20° 0′	23° ♉ *Retrog.*	12° *B*	2½°
12	6	10° 0′	15° ♉	6° *B*	8°

[Margin: Quibus Stellis fixis ſe asſociasſet, unâ eâdemq́; nocte.] *The fixed stars it would have joined in one and the same night.*

But to pursue this matter further, I think I should point out at the same time that the comet, at the said distance of 20 miles, with its longitudes and latitudes varying so rapidly and so enormously, would likewise have joined itself to different fixed stars in one and the same night. So in the second observation it would no longer have stood near those two stars in the foot of Perseus but, after the space of one short hour, not far from the head of Medusa; in the third observation, beside Alamak, that bright star in the southern foot of Andromeda; in the fourth observation, near the brighter one in the right foot of Andromeda; in the fifth observation, its course bending away from the star in the bend at the hips of Cassiopeia, it would have appeared very close to the star in the leg of Cassiopeia; in the seventh observation it would have been not far from the head of Erichthonius; next, in the eighth observation, heading towards Capella; in the ninth observation, passing the Kids; in the eleventh observation, joined once again to those two stars in the foot of Perseus; and finally, in the twelfth observation, the comet would have been seen overhanging the tail of ♈.

[Margin: An ejusmodi enormem imò ſummè admirabilem motum Cometa unquā exhibuerit? etiā penes ipſos Peripateticos eſto judicium.] *Has a comet ever shown such an enormous, indeed supremely marvellous, motion? Let the judgement rest even with the Peripatetics themselves.*

If, then, the comet is placed in the atmosphere, it is more certain than certain that it would have been subject to such changes and vicissitudes as we have now demonstrated to the eye from firmer foundations, and so would truly have had a motion that was wandering, varied, vagabond, tortuous, irregular and in no way proportionate. But of what sort this abortive motion, the leaping beyond all measure, the lawless dance, the erratic gyration, the winding and

the marvellous metamorphosis would have been, let our opponents themselves judge. I, for my part, am entirely convinced that no one will be so bold and so brazen-faced, unless he wishes to make himself a laughing-stock to the whole world, as seriously to ascribe such a motion to our comet. For not only could this have been clearly detected on December 26, when the comet clung quite firmly all night to the two stars in the foot of Perseus; the comet would also have performed these most intemperate and immoderate leaps on every single night, and these always unique, with wholly dissimilar courses, circuits (because from day to day it was gradually rising by its proper motion) and approaches to one fixed star after another, as you should note well. Indeed, I am not afraid to declare that of all the comets noted and observed since the beginning of the world by chronologers, historians, philosophers and mathematicians (and yet the number of those observed from the year 480 before the birth of Christ up to now amounts to at least 156), not a single one has ever appeared that produced such unusual and abnormal anomalies of motion.

[Margin: Autor ſibi perſuadet nullum prorsùs Cometarum à mundo condito illuxiſſe,qui talem vagabūdum & tortuoſum motumexercuerit.] *The author is convinced that not one of the comets since the creation of the world has shone that performed such a wandering and tortuous motion.*

[Margin: QuotCometæ ab anno 480 ante Chriſtum apparuerint.] *How many comets have appeared since the year 480 before Christ.*

[Margin: Iterum iterumque comprobatur Cometas univerſos nullo tempore in aëreâ ſubſtitiſſe regione.] *It is proved again and again that comets, all of them, have at no time stood still in the aerial region.*

Since, then, on December 26, from the very setting of the Sun almost until its rising, the comet continuously formed a straight line with the two in the foot of Perseus, apart from that variation of its proper motion; since, in the manner of the wandering stars, it showed longitudes and right ascensions that were supremely proportionate, retrograde and continuously decreasing, but latitudes and declinations that were always increasing, as our Ephemeris of the comet's apparent motion, appended to Book I, Section XI, attests; and likewise distances that grew gradually greater from the fixed stars it was moving away from, and little by little smaller from those it was approaching; since it by no means made such a rapid leap and, in a word, produced no such abortive and horrible parallaxes, but advanced with a supremely proportional and most regular motion beneath a certain definite portion of a great circle of the sphere (as I reported more fully above, in the preceding Book) — it is assuredly proven by evident arguments that both our comet and all the others (since they, no less than ours, were not subject to such enormities) were placed not in the air or atmosphere, even if you extend it to 20 German miles, but much higher.

[Margin: Cometa in aëre exiſtens vix duas horas ſupra horizontem commoratur.] *A comet in the air stays scarcely two hours above the horizon.*

[Margin: Cometa 1652 certo tempore per 17 hor. ſupra horizontem extitit.] *The comet of 1652 was, at a certain time, above the horizon for 17 hours.*

From here I come to the point we promised just now: that the comet, at the given distance of 20 miles from the earth, could not have stayed above our horizon for two hours, but would have had to be carried from rising to setting within two hours, with a motion that would certainly have been most rapid (to say nothing of its having performed such enormous motions and leaps in so tiny an interval of time). Yet it cannot be denied that it rose and set together with the fixed stars — on December 26, namely, together with those in the foot of Perseus. For I myself observed the comet more than 10 hours above the horizon at that time: in the evening at 4^{h} 30^{m}, when it first came into view, it was already elevated 35°; and in the morning at 2^{h} 30^{m}, when the last observation was made, it was still 30° from the horizon. And the comet was not only above our horizon for 10 hours but, to speak more accurately, was visible for 17 hours together with the two little stars in the foot of Perseus.

But to demonstrate clearly that at that distance the comet could not have stayed above the horizon even for two hours: let A B F D be a semicircle of the earth, A its centre, whose semidiameter A F is 860 German miles. Likewise let A C G I H E be the semicircle of the atmosphere, whose radius A G, or A H, is 880 miles, that is, 20 greater than the earth's. In the two right-angled triangles A F H, A F G, therefore, two sides are given, A G (or A H) and A F; the arc F H and F G is sought, or the angle F A H. If this is doubled, you will have the whole space that the comet completed above the horizon, or how long it could have appeared to us stationed at F.

[Margin: Demonſtratur Schemate & Calculo nonpotuisſeCometam ultra duas integras horas ſupra horizontem videri.] *It is demonstrated by a diagram and a calculation that the comet could not have been seen above the horizon for more than two whole hours.*

Diagram. An engraved figure in a plate-mark set into the text at the left of the measure: two concentric semicircles on a common straight diameter, the inner one the earth and the outer one the atmosphere, as the text describes them. The outer semicircle runs from E at the left end of the diameter through L, H, I and G to C at the right end; the inner one from D through F to B. A is the common centre on the diameter. A vertical line rises from A through F to I; a straight line runs from H to G across the top of the inner semicircle at F; straight lines run from A to H, from A to G and from A to L. Every label on the plate is listed below as read; none is supplied from the text. L is not named in the text of this page.

- On the outer semicircle, left to right: "E"; "L"; "H"; "I"; "G"; "C".
- On the inner semicircle, left to right: "D"; "F"; "B".
- On the diameter: "A" (the centre).
- Below the diameter: "Oriens." *east* (between D and A); "Occidens." *west* (between A and B); at the lower right, "Aut. ſculps." *the author engraved it*.

Logarithm of the side A F, the semidiameter of the earth, 860 — 245341
Logarithm of the hypotenuse A H, of the atmosphere, 880 *S.* — 243042

There remains the antilogarithm of the angle F A H — 2299. Its arc is 12° 14′ 20″.

[Margin: Magnitudo circuli parallactici.] *The size of the parallactic circle.*

[Margin: Quare Cometa neutiquam in aëre extiterit ? Fuisſet namq; ad 31 Decemb. prorsùs nobis inconſpicuus.] *Why was the comet by no means in the air? For until December 31 it would have been wholly invisible to us.*

Consequently, since the comet could neither have stayed above the horizon longer than $1^h\ 37^m\ 55^s$ nor, while visible, have completed more than the arc H I G of 24° 28′ 40″, it is rightly inferred from this, too, that it would have had to complete that whole circumgyration, or pseudo-circular leaping, which I mentioned above, in a quite similar space of time. The reason is evident: the diameter of that parallactic circle, in figure B above, is only a little greater than the arc H I G, or the diameter of the circle of appearance [circuli apparitionis]. And if we weigh the matter a little more finely still, and compare the diameter of the parallactic circle, of 33 degrees, with the arc of duration H I G, of 24° 28′ 40″, it follows absolutely, since the former is greater than the latter, that in that configuration the comet would have been wholly invisible to us and to everyone else until December 31; and only on the 31st, when it acquired a greater northern latitude, namely of 25 degrees, and from the vertical point of ou- rs was only 12° 14′ 20″ distant, would it have appeared on this horizon of ours (though somewhat sooner for those to the south, because of the lower elevation of the pole, and later by as much for those to the north). Yet this is most manifestly false, and contrary in every way to the observations. For not only did the comet shine continuously from the 20th, rising and setting at D and C — that is, on the rational horizon, which it always claimed for itself as its visible horizon — and not at G and H; but also, moving especially about the equator itself, it rose and set together with the other stars beside which it then stood; and likewise it cut the heaven entirely into two equal parts, namely at C E, and not into two unequal parts, G and H. Therefore, since entirely similar things have been found in all the other comets that have been faithfully recorded, all of them, together with this one of ours, were certainly not in the air. For the air can never be bisected in this way, because it is too near; but the heaven, since it is very far from the earth, and the earth is quite tiny in relation to the heaven, can be divided most fully into two equal parts — as is shown still more plainly by the construction set beside this.

[Margin: Denuò demonſtràtur Cometas eſſe æthereos.] *It is shown once again that comets are aetherial.*

Let the inner circle be the earth, the middle one the atmosphere, and the outer one the aether. Thus, from F on the earth's surface, a phenomenon is found to rise at M and set at N, since the aether, or heaven, is far enough from the earth, and the terrestrial globe bears a very small ratio — indeed almost none — to the distance of the aether. At C and E, however, we notice nothing at all from F, because of the bulging convexity of the earth and the very near distance of the phenomenon; and also because of the quite perceptible ratio between

the semidiameter of the earth and the distance of the atmosphere. Hence the whole hemisphere M O N comes into view for those stationed at F, and the whole heaven is entirely bisected; whereas of the aerial hemisphere C G H E only a small portion, G I H, is seen, which is much less than half. This is clear from the figure, even though no due proportion of the circles has been kept in it.

Diagram. An engraved figure in a plate-mark set into the text at the right of the measure: a large circle (the aether, as the text describes it) on a horizontal diameter from N at the left to M at the right, with O at its top; inside it, on the same diameter, a middle circle (the atmosphere) meeting the diameter at E and C, with H and G on its upper arc and I at its top; and an inner circle (the earth) meeting the diameter at D and B. A is the common centre on the diameter, and F is at the top of the inner circle. A short line runs through F from H to G; straight lines run from F to N and to M, and from F down to E and to C. A small arc is drawn between D and A. Every label on the plate is listed below as read; none is supplied from the text. The text names a pole L, which is not on this plate.

- On the large circle: "O" (top); "N" (left end of the diameter); "M" (right end of the diameter).
- On the middle circle: "I" (top); "H" (upper left); "G" (upper right); "E" (left, on the diameter); "C" (right, on the diameter).
- On the inner circle: "F" (top); "D" (left, on the diameter); "B" (right, on the diameter).
- On the diameter: "A" (the centre).
- At the lower right: "Aut. ſculp[?]." *the author engraved it* — the last letter before the point is undecided between s and long ſ.

[Margin: Cometa in aëre degens nullâ ratione poteſt fieri perpetuæ apparitionis, & quare ?] *A comet dwelling in the air can by no means become one of perpetual apparition; and why?*

[Margin: Id quod ſimul cum fixis oritur & occidit, id nullâ ratione eſt aëreum.] *Whatever rises and sets together with the fixed stars is by no means aerial.*

Besides these, another absurd consequence concerning the comet should also be noted: namely, that it could by no means at all have become one of perpetual apparition, as cannot be unclear from the preceding diagram. For it has already been proved that nothing whatever below H meets the eye — much less something that lies under the pole L, a point far below H. Therefore, since here at Danzig the comet was of perpetual apparition from December 28 right up to its departure — as I found with my own eyes, and it was also observed elsewhere by others — it is once again rightly inferred that the comet was not aerial. There is the further point that, together with the fixed stars, by the common motion (leaving aside on this occasion that other motion, the pro- per one), it advanced day by day, and that it also set together with those stars with which it had risen, as has already been stressed several times. For this reason Fortunius Lycetus [Fortunio Liceti], although otherwise most devoted

to the Peripatetic school, says rightly and shrewdly: that which moves with the motion of a star exists in the aether, and not in the air — as he deduces at length in *On Comets and New Stars* [de Cometis & novis Aſtris], Book V, Chapter XLV. And that an exhalation carried round in the uppermost air moves in a circle with a preternatural, accidental motion, one that is not wholly uniform, nor absolutely simple, nor exactly circular.

[Margin: Quanta parallaxis exoritura fuerit,exiſtente Cometâ in aëre; ſi nimirùm in diverſis regionibus animadverſus fuisſet.] *How great a parallax would have arisen if the comet were in the air: that is, if it had been noticed in different regions.*

These things indeed show abundantly enough what we should think about our phenomenon. Yet so that beginners, and those who are less practised in this astronomical dust, may learn these difficult and inherently obscure matters the more thoroughly and penetrate them more exactly, and so be better able to grasp the subtler parallaxes that I intend to discuss a little later, it will be useful, I think, to examine this subject more fully. We should investigate what kind and what size of difference in the parallax [diverſitatis adſpectus] the comet, existing in the air at that distance of 20 miles, would have produced, if it had been observed at the same time here at Danzig and at the same time in other places, whether southern or northern — that is, under different elevations of the pole (leaving aside for now the difference in the longitude of the places); and that it would not have been visible everywhere (as in fact it was) near the same fixed stars at the same time (setting aside also that difference of meridians).

[Margin: Obſervatio die 26 Dec. circa Cometam Dantiſci habita.] *The observation of the comet made at Danzig on December 26.*

For this purpose of ours the observation already brought forward by us earlier will serve no less well — the one made on the 26th, when here at Danzig the comet came into a straight line with the two stars in the foot of Perseus. But let us look at the very note on that observation, inserted on p. 8 of Book I: At about 6^{h} in the evening, the comet formed an almost straight line with the two fixed stars in the foot of Perseus; yet they were not at an entirely equal spacing from one another. For when the comet was observed more carefully, even with the naked eye, its centre stood from the heel at less, by ⅕ part, than the distance of the stars from each other. So the distance between the comet and the heel was estimated at about 1° 45′, the interval between the heel and the following star of the left foot of Perseus being given as 2° 10′.

[Margin: In quibusRegionibus Cometa in lineâ rectâ cum binis fixis inpede Perſei obſervatus.] *In which regions the comet was observed in a straight line with the two fixed stars in the foot of Perseus.*

[Margin: Quantam adſpectus diverſiſitatem inter Pariſios & Dãtiſcum Cometa, in diſtantiâ à terrâ 20 mill. exiſtens peperisſet.] *How great a parallax between Paris and Danzig the comet would have produced, if it had stood at a distance of 20 miles from the earth.*

This very same phenomenon appeared on the same day, in the evening, also at Königsberg [Regiomonti], Copenhagen [Hafniæ], Münster [Monaſterii], Leiden [Lugduni Batavorum], Brussels, Paris, and Digne [Diniæ] in Provence in France, as well as elsewhere in Europe. Meanwhile, however, let us compare with our Danzig observation only one of these, the Paris observation supplied by the most distinguished Bullialdo [Ismaël Boulliau], our most highly respected friend, deferring the rest to a stricter examination shortly; and so, by comparing these two with each other, let us demonstrate how great a parallax between Danzig and Paris [Lutetiam] the comet would have produced at the given altitude of 20 miles, and how enormously far from its Danzig station it would have appeared at Paris.

[Margin: Obſervatio Pariſienſis.] *The Paris observation.*

[Margin: Cometa aëreus neutiquã ſimul Pariſ. & Dant. rectum poſitum cum binis ſtellis Perſei obtinere potuiſſet.] *An aerial comet could by no means have held a position in a straight line with the two stars of Perseus at Paris and at Danzig at the same time.*

Boulliau describes this Paris observation as follows, on p. 12 of his observation [ſuæ obſerv.] published at Paris in the year 1653: *On December 26, with Aldebaran at an altitude of 35° 23′, at 6^h 16^m, the two stars of the left foot of Perseus, and the comet, were in the same straight line, the comet being nearer to the heel than to the other star, and more northerly and more westerly than the heel itself.* Likewise: *For quite a long time the comet and the two stars were in one straight line, and around 9^h the comet seemed to have passed beyond it by not much.* So he writes. You see, then, entirely the same position relative to those two stars in the foot of Perseus, both at Danzig and at Paris, at about the same hour, held by it. Yet this could in no way have happened if the phenomenon had been in the aerial region, as will become clear from what is about to be said.

Let A be the centre of the earth, B D L E its surface, F C G the atmosphere, I H K O the meridian of the starry heaven, C the comet, D Danzig, and L Paris [Lutetia Pariſiorum]. I say that the comet, standing on the meridian of Danzig near K, the little stars in the foot of Perseus, would by no means have shone beside them at Paris at the same time. Rather, removed into the northern quarter H — namely 126 degrees from those two stars, that is, in Hercules, near the Northern Crown — it would in reality have lain hidden at that time below the horizon of Paris, so that it would then have been wholly invisible to the people of Paris. But the matter will become clearer by a trigonometrical calculation, although on this occasion we shall use only a rather rough one, reserving more accurate numbers for their proper place.

Diagram. An engraved figure in a plate-mark set into the text at the right of the measure: a large semicircle (the meridian of the starry heaven, as the text describes it) on a horizontal diameter from O at the left to I at the right, with H on its upper arc and the engraved word "Meridianus." along the arc to the right of H. At the upper left of the arc stands K, with two small six-pointed stars just below it, unlettered. Two small concentric semicircles stand on the

same diameter about A: the outer one (the atmosphere) meets the diameter at G and F, the inner one (the earth) at E and B. C is on the outer small arc at its upper left; D is on the inner arc to the right of C, and L on the inner arc to the left, below C. A straight line runs from H through C down to L, and another from K through C down to D. Dotted lines run from C to a point m and from L to a point n, and a dotted line runs from near n down to A. Every label on the plate is listed below as read; none is supplied from the text.

- On the large semicircle: "H" (top, right of centre); "Meridianus." *meridian* (along the arc, right of H); "K" (upper left), with two unlettered star marks below it.
- On the diameter, left to right: "O"; "G"; "E"; "A" (the centre); "B"; "F"; "I".
- Near the small semicircles: "C" (on the outer arc, upper left); "D" (on the inner arc, right of C); "L" (on the inner arc, left); "m" and "n" (italic, at the ends of the dotted lines, between C and L).
- At the lower right: "Aut. ſculp[?]." *the author engraved it* — the last letter before the point is undecided between s and long ſ.

[Margin: Elevatio Poli Pariſienſis & Dantiſcana.] *The elevation of the pole at Paris and at Danzig.*

First, we are given the latitude of the place at Danzig, that is, the elevation of the pole at D, of about 54° 23′, and that of Paris, L, according to Boulliau, of 48° 51′. The difference is therefore 5° 32′, namely the distance D L between Danzig and Paris. Half of this, m L, or the angle m A L or n A L, will be 2° 46′. Since the hypotenuse A L is also known — the semidiameter of the earth, namely 860 — the side L n is found in the plane right-angled triangle, by logarithms, in this way: the sum of the logarithms of the hypotenuse and of the angle opposite the side sought is the logarithm of the side sought.

Second, from the same angle and the hypotenuse L A, the semidiameter of the earth, 860, the side A n results. For the sum of the antilogarithm of the angle and the logarithm of the hypotenuse makes up the logarithm of the side sought. And when the side A n is subtracted from A C (which consists of the earth's semidiameter and the atmosphere), C n remains.

[Margin: Quantus angulus Parallacticus ſit inter Lutetiam & Dantiſcum, Cometâ exiſtente in aëre.] *How great the parallactic angle is between Paris and Danzig if the comet is in the air.*

Third, in the triangle C n L, from the two sides C n and n L that enclose the right angle, the semiparallactic angle n C L is found. For the logarithm of the greater side, subtracted from the logarithm of the lesser, leaves the mesologarithm + of the smaller angle, whose complement is the greater angle sought. If this is doubled, the whole parallactic angle D C L that we are seeking becomes known.

Logarithm of the angle n A L, 2° 46′ — 303097
Logarithm of the hypotenuse A L, 860 — 245341 A.
Logarithm of the side L n — 548438 — 41½ *German miles*

Antilogarithm of the angle n A L, 2° 46′ — 117
Logarithm of the hypotenuse A L, 860 — 245341 A
Logarithm of the side A n — 245458 — 859 *miles*, A n. *Subtracted from* 880 *miles*, A C
Logarithm C n — 616582 — 21 *miles*, C n.
Logarithm L n — 548438 *Subtracted.*
Mesologarithm of the half-angle of parallax n C L — 68144 — 26° 50′
Its complement to 90 — 63° 10′
Therefore the whole angle of parallax D C L, *or its vertical angle* K C H — 126° 20′

By so many degrees, therefore, the comet would have stood away at Paris from its station on the meridian of Danzig, K, towards the north at H, because Paris lies further south than Danzig.

[Margin: Evidenti argumento iterum corroboratur Cometas extra ſphæram noſtrã vaporoſam verſari.] *A clear argument confirms once again that comets dwell outside our vaporous sphere.*

But it has never been found, either in our comet or in other true comets, that at the same time two different observers in different places, however far apart, noted so great a difference and parallax, and that one of them saw the comet in the south and the other in the north, removed more than 126 degrees from the first station. It therefore remains most true that comets are raised far above the atmosphere.

[Margin: Ex Regiomontanâ obſervatione quoq; comprobaturCometam fuiſſe in æthere.] *From the Königsberg observation, too, it is proved that the comet was in the aether.*

This is proved no less clearly from the observations of places much nearer together: namely our own at Danzig and the Königsberg observation of the most distinguished Linemanni [Albert Linemann]. He saw the comet on the same evening, of December 26, near the foot of Perseus, as can be seen from his *Letter* [Epiſtolâ] printed at Königsberg: *On December 26, at* 5^h 15^m *in the evening, the comet stood in an entirely straight line with the two little stars of the foot of Perseus, Z and o of Beyeri [Johann Bayer]; but in such a way that the comet, lying further to the right, was somewhat nearer to the heel than the foot itself was.* Just as here at Danzig and at Paris.

[Margin: Differentia Meridianorum inter Regiomontum & Dantiſcum.] *The difference of meridians between Königsberg and Danzig.*

[Margin: Elevatio Poli Regiomontana correcta.] *The elevation of the pole at Königsberg, corrected.*

But let us see how great a parallax would have arisen between Danzig and Königsberg (places whose difference of meridians is found to be only 7′, and their true distance only 14 miles) at the same distance of the comet from the earth, 20 miles. The investigation is entirely the same as the previous one, except that it rests on other data.

The elevation of the pole at Königsberg is very nearly 54° 43′, according to both Tycho and Linemann, and by no means 55° 8′, as Kepplerus [Kepler] wrongly recorded, or 54° 21′, as Longomontanus did. The difference between the Danzig and Königsberg elevations therefore comes out at 20′; half of it is 10′, whose

Logarithm n A L — 583999
Logarithm of the hypotenuse A L 860 — 245341 A.
Logarithm of the side L n — 829340 — 3 *miles*.
Antilogarithm of the angle n A L — 0
Logarithm of the hypotenuse 860 — 245341 A.
Logarithm of the side A n — 245341 — 860 A n
880 A C
20 C n
Logarithm C n — 621461 S.
Logarithm L n — 829340
Mesologarithm of the half-angle n C L — 207879 — 7° 8′
The whole parallactic angle — 14° 16′

[Margin: Angulus parallacticus inter Dantiſcum & Regiom.Cometâ verſante in diſtantiâ 20 mill.] *The parallactic angle between Danzig and Königsberg if the comet is at a distance of 20 miles.*

Consequently, according to this calculation, the comet ought to have appeared not in a straight line with both stars in the foot of Perseus, as it did here at Danzig, but 14 degrees further from the heel, and lower by as much towards the horizon, since Königsberg lies further north than Danzig. And hence, on the evening of December 26, while the comet stood in a straight line with the foot of Perseus here at Danzig, it would have shone 5° below the Pleiades — wholly against Linemann's observation.

[Margin: Quot milliaribus diſtet Regiomontum à Dantiſco.] *How many miles Königsberg is from Danzig.*

[Margin: Elevatio Poli, & differentia Merid. Dinienſis.] *The elevation of the pole, and the difference of meridians, at Digne.*

[Margin: Enormis admodùm parallaxis longitudinis inter Diniam & Dantiſcum; Cometa ſi detur in aëre.] *An utterly enormous parallax of longitude between Digne and Danzig, if the comet is supposed to be in the air.*

Since, then, so great and so widely varying a parallax arises between Danzig and Königsberg — places so close together, only 14 miles apart in a straight line — if the comet is in the air, how great indeed will it be between Danzig and Digne in Provence, the residence of that most celebrated man Gassendi, whose elevation of the pole is only 44° 6′, so that the difference of meridians is 10° 17′; especially if the parallax of the longitude of the places is computed at the same time (which is easily derived on the same basis, if in place of the difference of latitude you put the difference of longitude, and in place of the meridian the equator), and the other parallaxes are then added — namely of altitude, longitude, latitude, right ascension and declination. Good God, what kind and

how great would be the diversity of the comet's aspect, and how great the motions' confusion that would arise! If this had to be set out exactly, a good many pages would scarcely hold it. But since the more expert can easily imagine this remarkable variety for themselves even without my saying it, and the rest, too, leaving these matters aside, will by now have learned the absurdities well enough from what has been said, I restrain myself, so that our adversaries, who hold that comets are aerial, may not be made to blush any further.

[Margin: Nonnulli Peripateticorum, nimias iſtas abſurditates evitandi gratiâ, paullò altiùs Cometas attollunt.] *Some of the Peripatetics, to avoid these excessive absurdities, raise comets a little higher.*

But some of the Peripatetics abandon this opinion because of its very many inconveniences and absurdities, and raise comets somewhat higher than vapours usually ascend — namely into the clearer region of air or of fire, as Keckermann does in Book VI of his *Physics*, and others too — to 100, indeed to 1000 miles; above all, in order at the same time to free them entirely from those parallaxes that spring up [?]. Since they do so, it will not be out of place to examine the parallaxes accurately at a more remote distance from the earth as well, from that same observation of December 26.

[Margin: In gratiamPeripateticorum Autor Cometas ad 2580 mill. removet.] *As a favour to the Peripatetics, the author removes comets to 2580 miles.*

[Margin: Nec ſic poſſe inconvenientias omnes evitari, luculẽter Schemate demonſtratur.] *That not even so can all the inconveniences be avoided is clearly shown in a figure.*

It may seem, however, that we would be indulging the Peripatetics too far if we allowed them so freely to remove the comet at once from 20 to 1000 miles. Yet to make the matter still [?] more evident, let us grant that the comet is removed not only to 1000 miles but to 3 semidiameters of the earth, that is, to 2580 miles. Even so it will be perfectly plain that not even in this way can those enormous parallaxes and those remarkable changes be entirely avoided, but that the latitudes and declinations, no less, change notably with respect to the two stars in the foot of Perseus. Let us therefore take up the task again by the method already shown.

Diagram. An engraved figure in two parts, set across the measure below the text; its lettering is in an engraved italic hand. In the upper part, a horizontal ruled line runs across the figure, with a dotted line just above it. An *e* stands at the left end of the ruled line, and eleven further stations follow, each an *f* (a flourished stroke) on the dotted line above an *e* on the ruled line. The words *Verus Cometæ locus.* ("The true place of the comet") are engraved below the ruled line at its left, middle and right. From each of the twelve *e* a dotted vertical descends, with a value in degrees set along it, reading upward. Below stand twelve numbered triangles, each formed by two six-pointed stars on its base and a hatched disc (the comet) at its apex, which stands on the foot of its dotted vertical. The disc rises from the first triangle to the sixth and seventh and then falls again, and each triangle has a value in degrees set along its right

side, reading upward. Under the triangles are the words *Observatio. Quadrans Orientalis.* ("Observation. Eastern quadrant") under triangles 2–4, *Meridies.* ("Noon") under triangle 6, and *Observatio. Quadrans Occidentalis.* ("Observation. Western quadrant") under triangles 9–10, and below them a row of hour labels, one under each triangle. The lower part is a star chart. Five stars of Perseus are labelled (two stars stand by the label for the foot), and Algol is labelled at the right. Twelve hatched discs, numbered 1 to 12 but not in numerical order across the chart, are joined by a dotted line. Dotted verticals drop from the discs to a horizontal line, the ecliptic, with Cancer's sign at its left end and Aries's at its right. Values of latitude stand along the verticals, and values of longitude stand above and below the ecliptic where the verticals end. Every label on the figure is listed below as read; none is supplied from the text.

- e (12): on the ruled line, one at its left end and one under each *f*.
- f (11): on the dotted line above the ruled line, one over each *e* after the first.
- Verus / Cometæ / locus. (below the ruled line, left, middle, right): "The true place of the comet".
- Values along the dotted verticals, left to right: 18°, 16° 47′, 15°, 12°, 9° 36′, 8°, 9° 36′, 12°, 15°, 16° 47′, 18°, 19°.
- Letters at the triangles: triangle 1 *a*, *b*, *c*; triangle 2 *a*, *b*, *c*, *d*; triangle 3 *c*, *d*; triangles 4 and 5 *c*; triangle 6 *a*, *b*, *c*, *d*; triangles 7 to 10 *c*; triangles 11 and 12 *a*, *b*, *c*, *d*. In each case *c* is at the comet's disc, *a* and *b* at the base stars, and *d* beside the right side of the triangle.
- Values along the triangles' right sides, triangles 1 to 12: 22°, 30°, 40°, 50°, 60°, 64°, 60°, 50°, 40°, 30°, 20°, 10°.
- Triangle numbers: 1., 2., 3., 4., 5., 6., 7., 8., 9. [?], 10., 11., 12. The figure under the ninth triangle is a curled sort unlike the other 9s on the plate, and is read as 9 only by conjecture.
- Obſervatio. / Quadrans Orientalis. (under triangles 2–4): "Observation. Eastern quadrant".
- Meridies. (under triangle 6): "Noon".
- Obſervatio. / Quadrans Occidentalis. (under triangles 9–10): "Observation. Western quadrant".
- Hour labels, triangles 1 to 12: *Hor.* 5., 6., 7., 8., 9., 10., 12., 1½., 2½., 4., 5., 6. ("Hour 5" and so on).
- In ſiniſtro femore Pers. (upper left of the chart): "In the left thigh of Perseus".
- In ſiniſtro genu Persei. (left): "In the left knee of Perseus".
- Algol. (right, beside its star): Algol.
- In ſiniſtro crure Persei. (left): "In the left leg of Perseus".
- In pede Persei. (lower left): "In the foot of Perseus".
- Comet positions: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

- Latitudes along the verticals, left to right: *Latit* 16°, 20½°, 14°, 13 and a fraction whose numerator is 1 and whose denominator is lost where a dotted line crosses it [?], 13½°, 14°, 22°, 15½°, *Latitud* 18°.
- ♋ (left end of the ecliptic) and ♈ (right end).
- Ecliptica. (above the line, left and right): "Ecliptic".
- Longitudes above the ecliptic, left to right: 29, 26, 23, 22; below it: 29½, 27, 25, 22½, 20½.
- Oriens. (below the line, left): "East"; Occidens. (below the line, right): "West".
- Tauri / Cometæ / Longitudo (below the middle figures): "of Taurus"; "Longitude of the comet".
- Autor ſculpsit. (right of the ecliptic): "The author engraved it".

In the preceding figure, let those first 12 observations be drawn at the same times and at the same altitudes as in Figure B, and let *f c* be the parallax of altitude belonging to each observation, taken from the table in this Book, p. 141. From this it is clearly gathered that at this distance of the comet, too, the appearance of that straight line would have been wonderfully changed and swung about every hour — indeed every quarter of an hour — from the very first observation to the last. And this to such a degree that at the second observation, within the space of one hour, the comet would already have become higher by a whole degree and more; at the third observation by about three degrees; at the fourth by about 6 degrees; at the fifth by 9 degrees; at the sixth by 10 degrees; and then it would have descended again in almost the same way. In this way the triangle that the comet formed with the two little stars would continually have taken on one very noticeably different shape after another.

[Margin: Cometam 2580 mill. altiùs extitiſſe.] *That the comet stood higher than 2580 miles.*

But with our comet things turned out entirely otherwise. Its latitudes and declinations by no means increased by as much as 10 degrees in an interval of 5 hours, nor did they decrease afterwards in a like space of time; rather, through the whole night of December 26, the phenomenon advanced in its orbit towards Cassiopeia, keeping the strictest proportion, while its latitudes and declinations increased meanwhile at every altitude. It is therefore again inferred, and quite rightly, that the comet was carried far higher, beyond 2580 miles.

[Margin: Mira diverſitas adſpectus in hâc Cometæ diſtantiâ.] *The remarkable parallax at this distance of the comet.*

I add that in this case the comet would have varied not only its latitudes and declinations, by as much as 10 degrees, but equally — as at the earlier given distance of 20 miles — its longitudes and right ascensions by about as many degrees, even when its proper motion is duly allowed for. No less would it have been continually wheeled about, and been now direct, now stationary, now retrograde, as is plain from the lower drawing of the preceding figure: that is, the comet would have shown itself at first retrograde up to the 4th

observation, and stationary; afterwards direct up to the 8th observation; and finally, after making its second station, retrograde in its turn. After this it would have presented remarkable changes with respect to the fixed stars. For just as at hour 5 in the evening it was joined to the heel of Perseus, so at hour 8 it would already have stood by the Head of Algol; next, at hour 10, by the left thigh of Perseus; at about hour 1, by the left knee; at hour 2, by the left leg of Perseus; and at hour 4 in the morning, by the heel once more. But all those changes at this given distance of the comet — of longitude and latitude as well as of distance from the heel, and of its visible place with respect to the fixed stars — appear more clearly at a single glance in the little table below.

The variation of the immoderate course, at a distance of the phenomenon of 2580 miles. [Variatio immoderati incesſus, ad diſtantiam phænomeni 2580 mill.]

Observation	Evening hour	Altitude of the comet	Longitude of the comet	Latitude of the comet	Distance of the comet from the heel	Approach to the fixed stars
1	5	22° 0′	25° ♉	13° *Bor.*	2°	Near the heel of Perseus.
2	6	30° 0′	23° ♉ *Retrogr.*	14° *Bor.*	2¾°	
3	7	40° 0′	22° ♉	15½° *Bor.*	4½°	
4	8	50° 0′	20½° ♉ *Station.*	18° *Bor.*	6¼°	Near Algol.
5	9	60° 0′	22½° ♉	22° *Bor.*	9°	
6	10	64° 0′	26° ♉ *Directus*	23° *Bor.*	10°	Near the left thigh of Perseus.
7	12	60° 0′	29° ♉	20½° *Bor.*	9°	About the left knee of Perseus.
8	1½ *m.*	50° 0′	29½° ♉ *Station.*	16° *Bor.*	6° *circ.*	About the left leg of Perseus.
9	2½	40° 0′	27° ♉	14½° *Bor.*	4½°	
10	4	30° 0′	26° ♉ *Directus*	13½° *Bor.*	2¾°	Near the heel of Perseus.
11	5	20° 0′	25° ♉	13° *Bor.*	2° *& paul.plus*	
12	6	10° 0′	23° ♉	12° *Bor.*	2°	

But the very opposite happened with our comet. Through the whole night, if you except its proper motion, it clung steadily to the foot of Perseus, according to the observations of everyone. Our opinion therefore stands on a firm foot.

[Margin: Quàm diuCometa 3 ſemid.à terrâ remotus potuiſſe ſupra horizontem conſpici.] *How long the comet, removed 3 semidiameters from the earth, could have been seen above the horizon.*

Moreover, the comet could not have stayed above the horizon as long as it actually did, but in that position only $10^{h}\ 2^{m}$. This, too, is plainly shown by the figure inserted on p. 152. For, given the earth's semidiameter A F, 860, and A H, made up of A F and the distance from the earth, 2580 miles — that is, 3440 miles — the angle F A H, or G I H, results.

Logarithm of the side A F, *the semidiameter of the earth*, 860 — 245341
Logarithm of the hypotenuse A H, 3440 — 106711 *Sub.*
There remains the antilogarithm of the angle sought, F A H — 138630 — 75° 31′
Therefore G A H, *or the arc* G H — 151° 2′

This angle, converted into degrees, gives 10^h 2^m — the stay, that is, above the horizon — whereas the stay was in fact found to be 17 hours. Therefore it is certain on this ground too that the comet must be raised much higher.

[Margin: Aliâ ratione convincitur, Cometam altiorem extitisſe.] *By another argument it is proved that the comet stood higher.*

This is proved more and more by the observations from different places as well. Let us therefore take our Danzig observation and that of P. Gassendi at Digne, for the same distance of the comet from the earth, namely 2580 miles. In the figure above, on p. 155, the elevation of the pole at Digne is given as 44° 6′, and that at Danzig as 54° 23′. The difference of latitude, then — that is, between Danzig, D, and Digne, L — is 10° 17′, and so the half-difference is 5° 8½′, being the angle n A L, of which:

Logarithm — 241219
Logarithm of the hypotenuse A L, 860 — 245341 *Add.*
Logarithm of the side L n — 486560 — 77 *mill.*
Antilogarithm of the angle n A L — 403
Logarithm of the hypotenuse A L, 860 — 245341 *Add.*
Logarithm of the side A n — 245744 — 857 A n

3440 A c, *from* A m, *the semidiameter of the earth*, 860, *and* m C, *the distance*, 2580

2583 C n
Logarithm C n — 135363 *S.*
Log. L n — 486560
Mesologarithm of the angle — 351197 — n C L 1° 42′
Whole parallactic angle D C L — 3° 24′, *or* H C K

[Margin: Angulus parallacticus inter Dantiſcum & Diniam,Cometâ à Terrâ remoto 3 Sem. Terræ.] *The parallactic angle between Danzig and Digne, with the comet removed 3 semidiameters of the earth from the earth.*

Consequently, the comet would necessarily have appeared to Gassendi at Digne more northerly and higher by so many degrees and minutes, while here for us at Danzig the same comet shone in a straight line with the two stars in the foot of Perseus, because Digne is more southerly than Danzig. This is flatly contrary to the Digne observation, which the said Gassendi communicated by letter to Boulliau on 1653 January 16, in these words:

[Margin: Dinienſis obſervatio Cometæ.] *The Digne observation of the comet.*

"I do not know whether I told you in my previous letter that I too, on the evening of December 26, found the comet in the same straight line as the two fixed stars in the left foot of Perseus, but a very little farther from the heel than the heel is from the other star, which is the bright one and in the front part of the foot. Be that as it may, to have

seen this phenomenon in Paris and at Digne in the same line at about the same hour is not to be made light of, for such an observation is of great moment." So he writes.

But since the comet, wherever it was observed, in whatever place, formed a straight line with the two little stars in the foot of Perseus most constantly and evenly on that same night, and in no way deviated enormously this way or that, the same follows as before: that the comet stood higher than 2580 miles.

[Margin: Alii Cometas altiores fingũt.] *Others imagine comets higher still.*

This opinion is also embraced by not a few of the Peripatetics, such as Nolthius, Claramontius [Scipione Chiaramonti] and others. Indeed, they remove comets from the earth not only to 3 but even to 8 and 9 semidiameters of the earth, that is, to 6880 and 7740 miles, so that they may extricate themselves the more readily from that net of parallaxes.

[Margin: Quantæ ſint parallaxes Cometarum in diſtantiâ 10 Semid. Terr.] *How great the parallaxes of comets are at a distance of 10 semidiameters of the earth.*

For their sake, then, let us examine whether at such an elongation, too, any parallax arises, and how great. But to be the more generous, let us grant them that the phenomena are removed to 10 semidiameters of the earth, that is, 8600 German miles, and then that they are raised even to 20 semidiameters of the earth, that is, to 17,000 — a distance much greater indeed than they themselves set. Yet we shall find that even so the parallaxes do not vanish entirely.

To that end we have added these three figures, Fig. C. In them B D marks the horizon; B C D the vertical circle from east towards west; *a* the left foot of Perseus; *b* the heel; *c* the comet, or its apparent place; *d* its true place; and *d c* the difference between the true and the apparent place, that is, the parallax. The upper figure is drawn for an elongation of the comet from the earth of 10 semidiameters, or 8600 miles; the middle one for a distance of 20 semidiameters of the earth, that is, 17,000 miles; and the lower one for an elongation of 55 semidiameters of the earth, or 47,300 miles, the Moon's mean distance from the earth. The first observation, towards the east, shows the comet in a straight line with the two fixed stars in the foot of Perseus at hour 5 in the evening, with the heel at an altitude of 22 degrees.

The second observation: at hour 6 in the evening, with the heel at an altitude of 34

The third observation: at hour 8 in the evening, with the heel at an altitude of 50

The fourth observation: at hour 10 in the evening, with the heel at an altitude of 64

The fifth observation: at hour 12, with the heel at an altitude of 60

The sixth observation: at hour 2 in the morning, with the heel at an altitude of 45

The seventh observation: at hour 4 in the morning, with the heel at an altitude of 28

The eighth observation: at hour 6 in the morning, with the heel at an altitude of 12

With these various altitudes and distances of the phenomenon thus given in these figures, very different parallaxes also result. How great they are in the first drawing, at a distance of 10 semidiameters of the earth, for each observation and altitude, as found from the parallactic table, you will have in this little table:

[Margin: Variatioparallaxeos in diſtantiâ Cometæ 10 S. T.] *The variation of the parallax at a distance of the comet of 10 semidiameters of the earth.*

Observation	Altitude of the heel	Parallax *d c*
1	22°	5° 19′
2	34°	4° 45′
3	50°	3° 33′
4	64°	2° 31′
5	60°	2° 52′
6	45°	4° 3′
7	28°	5° 4′
8	12°	5° 37′

Hence, since the parallaxes vary so very greatly among themselves from the very first observation, the comet too must continually rise noticeably and decline from that straight line, and the triangle that it forms with the two little stars in the foot of Perseus must vary very quickly, as is clear from the upper of the three figures added. So at the fourth observation, near the meridian, at an altitude of the comet of about 64 degrees and in its higher position, the triangle of that observation would have been the largest of all, and the phenomenon itself would have appeared 2° 48′ higher than at the first observation. In the western quadrant, however, as the comet gradually descends in turn, the triangles contract again. In the same way the distances from the heel, the latitudes and the declinations increased at the rising by about 3 degrees, just as they decreased at the setting. Moreover, the longitudes and right ascensions, as we have already shown above for the nearer position, would have been greatly changed; the comet now direct,

Diagram. A full-page engraved plate, Fig. C, with three figures set one above the other. Each is a half-disc: an arc rising over a horizontal base line, with the words *Ortus.* ("Rising"), *Horizon.*, *Meridies.* ("Meridian"), *Horizon.* and *Occaſus.* ("Setting") along the base from left to right. Inside each half-disc, eight numbered stations run along the arc from the rising at the left over the top to the setting at the right. At each station a hatched disc, lettered *c*, forms a triangle with two six-pointed stars lettered *a* and *b*, and a dotted vertical rises from the disc to a letter *d*. From the second station on, a further letter stands free to the right of and below the disc, near no star, usually with a small point beside it; it is read as *h* by conjecture only [?]. Inside the arc, five further numbered stations show a second hatched disc lettered *f*, with a dotted vertical rising to a letter *g*; beside it a cluster of five or six small stars, the nearest lettered *e*; from the second of these stations on, a line runs down from *f* to a letter *i* and across to *e*, closing a triangle. The three figures differ in their titles, which

give the distance from the earth, and in the shapes of their triangles. *Fig. C* is engraved in the lower figure, and *Autor ſculpſit.* ("The author engraved it") below its frame at the right. Every label on the plate is listed below as read; none is supplied from the text.

- Upper figure, title: *Diverſitas Cometæ / Adſpectus, in diſtantiâ / à Terrâ 10 S. T. / ſive 8600 mill.* — "The difference in the appearance of the comet at a distance from the earth of 10 semidiameters of the earth, or 8600 miles."
- Middle figure, title: *In diſtantiâ à Terr. 20 S.T. / ſive 17000 milliar.* — "At a distance from the earth of 20 semidiameters of the earth, or 17000 miles."
- Lower figure, title: *In diſtant. à Terr. 55 S. T. / ſive 47300 milliar.* — "At a distance from the earth of 55 semidiameters of the earth, or 47300 miles."
- Stations of the first disc, in each of the three figures: numbered 1, 2, 3, 4, 5, 6, 7, 8. Station 1 carries *d*, *c*, *a*, *b*; stations 2 to 8 each carry *d*, *c*, *a*, *b* and the free letter *h* [?].
- Stations of the second disc, in each of the three figures: numbered 1, 2, 3, 4, 5 (the upper figure prints "4."). Station 1 carries *g*, *f*, *e*; stations 2 to 5 each carry *g*, *f*, *i*, *e*.
- Along the base of each figure: *Ortus.*, *Horizon.*, *Meridies.*, *Horizon.*, *Occaſus.*
- *Fig. C* (in the lower figure, left of centre); *Autor ſculpſit.* (below the lower frame, at the right).

now stationary, now retrograde: so it would have been, with this difference, however, that in this position the parallactic circle would have grown, according to the parallaxes, to only three or four degrees, if you do not exclude the proper motion.

[Margin: Quantus in hâ[c?] diſtantiâ,circulus ſit parallacticus.] *How great the parallactic circle is at this [?] distance.*

Even so, as anyone can readily judge, this variation of appearance and this circling round would have been perceptible enough to everyone, if, that is, our comet had been endowed with such a variation and rotation. But since this was in no way detected either by us or by others living anywhere at all, what else, I ask, are we to conclude than that the comet occupied a place much higher still than 8600 miles?

[Margin: Comet. 1652 altiorem fuiſſe 8600 evidenter demonſtratur.] *It is clearly demonstrated that the comet of 1652 was higher than 8600.*

We shall be made all the more certain of this conclusion, the more plainly we are about to show that even at the said distance of the comet, 8600 miles, the parallax between different places — between Danzig and Digne, for example, that is, between us and Gassendi — does not vanish entirely.

[Margin: Ex obſervatione Dinienſi & Dantiſcanâ.] *From the observation at Digne and at Danzig.*

Let us compute that parallax by the method used above, and with the help of the figure given on p. 155, though with less labour, since most of the lines bearing on the parallactic angle, namely L n and A n, are already known from there, and only the last triangle, n C L, remains to be solved.

Since A n *is thus known,* 857 *S.*

A C 9460, *from the semidiameter of the earth and the distance of the comet there results* C n 8603

Now in the triangle n C L, from the two given sides C n and n L, which enclose the right angle, the half-parallactic angle n C L is found.

Logarithm C n — 15046 *S.*

Logarithm L n — 486560

Mesologarithm of the angle — 471514 — 0° 31′

Therefore the whole parallactic angle D C L — 1° 2′, *or* H C K.

[Margin: Angulus Parallacticus inter Dantiſcum & Diniam.] *The parallactic angle between Danzig and Digne.*

And so between Danzig and Digne the difference in the comet's position would have been so great that at Digne the comet would in no way have been seen near the heel, much less in a straight line; and yet Gassendi's observation, quoted above, testifies very clearly that this is exactly what he observed.

[Margin: Variatio motus Cometæ in diſtantiâ 20 Semid[[./:]] T[[./:]]] *The variation of the comet's motion at a distance of 20 semidiameters of the earth.*

Let us now go on to consider and work out, too, how great the parallaxes and changes the comet would have shown at an elongation of 20 semidiameters of the earth, or 17,000 miles, although terrestrial exhalations certainly cannot reach so far. The middle figure of the preceding Fig. C will serve this purpose of ours; its parallaxes of altitude, corresponding to that elongation of 17,000 miles, are shown in the following little table:

Observation	Altitude of the heel	Parallax *c d*
1	22°	2° 39′
2	34°	2° 22′
3	50°	1° 50′
4	64°	1° 16′
5	60°	1° 26′
6	45°	2° 2′
7	28°	2° 32′
8	12°	2° 48′

The variation of motion at this given distance is indeed somewhat more moderate than at the former one, nearer the earth, and the triangles likewise are somewhat smaller and more obtuse. None the less, the comet, which forms a straight line with the two stars in the foot of Perseus, would have made noticeable and conspicuous advances, or rather excursions, from the first observation up to the fourth: it would have stood about 1½ degrees higher, and more than 3 degrees away from the heel, although at about the first observation it was scarcely two degrees away. And so, in the space of 4 hours, from 6 to 10 in the evening, by a whole degree, indeed by a whole degree and a half, if the motion is added, it would have stood farther off than was actually observed, and farther than it could have advanced even by its own proper motion (which, as

can be gathered from the table of proper motion, amounted to only 45 minutes). Again, from the 4th to the 8th observation the triangles would have decreased in much the same way as the comet approached the heel, and would indeed in turn have come back to the straight line of the two fixed stars in the foot of Perseus. Hence the latitudes would have shown themselves now greater, now smaller, by up to 1½ degrees; and, owing to the inconstant longitude and the reciprocating motion, the comet would have described a parallactic circle of 1½ degrees and at the same time shown a parallax between different places. Let us now see how great that parallax comes out at a distance of 17,000 miles, namely between Danzig and Digne.

[Margin: Nec in hoc ſitu phænomena ſalvantur.] *Nor are the phenomena saved in this position either.*

Since the remaining data have already become known above, only the angle n C L remains to be computed. This time let us derive it from the table of sines and tangents, since our logarithmic table is constructed only up to 10000.

Thus there are given: the distance of the comet — 17,000 — m C
the semidiameter of the earth — 860 — A m
the side A C — 17,860 — A C
857 — A n, *found on p. 159.*
There results the side C n — 17,003

Now, therefore, as C n, 17,003, is to n L, 77 miles, so is the whole sine, 100,000, to the tangent of the angle n C L, 453, whose arc is 0° 15′ 36″; the whole angle, namely D C L or H C K, is 0° 31′ 12″.

[Margin: Abſurdum omninò Cometam in aërem rejicere.] *It is utterly absurd to relegate the comet to the air.*

Accordingly, even in this position, Gassendi should have found the comet on December 26, in the evening, at about the same hour, not in a straight line with the two little stars in the foot of Perseus but half a degree higher, towards the head of Medusa. But since things turned out quite otherwise with it, and it lacked any perceptible parallax, let the Peripatetics themselves judge, I beg them, whether it is not absurd to place the comet in the air, even at a distance of 17,000 miles.

[Margin: Cometam Lunâ altiorem fuiſſe comprobatur.] *It is proved that the comet was higher than the Moon.*

Finally, to satisfy all the more fully both our own desire and that of all other lovers of truth, we shall also show, but briefly, from the lower of the three preceding figures of the preceding Fig. C, that our phenomenon was placed higher even than the Moon, which stands at a mean elongation from the earth of 55 semidiameters of the earth, that is, 47,300 miles.

Observa-tion	Altitude of the heel	Parallax *c d* at a distance of 55 semidiameters of the earth
1	22°	57′ 16″
2	34°	51′ 48″

Observa-tion	Altitude of the heel	Parallax *c d* at a distance of 55 semidiameters of the earth
3	50°	40′ 10″
4	64°	27′ 22″
5	60°	31′ 15″
6	45°	44′ 12″
7	28°	55′ 11″
8	12°	61′ 8″

For it is evident, both from the figure assigned and from this little table of parallaxes, that even at this distance, so far from the earth, the comet is not entirely free from every parallax. This is plain both from those triangles, drawn in due proportion according to the parallaxes belonging to each altitude, and from its differing position relative to the heel, and also from its very different altitude with respect to that straight line. For from the first to the fourth observation the comet would have been seen half a degree higher than could have come about by reason of its proper motion, so that, just as above, the distances as well as the latitudes and declinations would have increased in the eastern quadrant by half a degree and more, and decreased, by contrast, in the western; add that at the same time the parallactic circle would then have appeared as 34′,

[Margin: Quantus circulus Cometæ parallacticus extitisſet ſub orbe Lunari.] *How great the comet's parallactic circle would have been beneath the lunar orb.*

and the comet would have been now direct, now retrograde, by so many minutes; whereas in fact, as the observations show — above all the table of latitude, declination, longitude and right ascension — it was carried continually against the order of the signs, and upward.

[Margin: Conſtitutio Cometæ ad Pleiadas.] *The comet's configuration near the Pleiades.*

But so as not to linger over these points too long, it should be understood that whatever we have said and explained at length, with the help of the three figures above, about the comet's position near the foot of Perseus as observed on December 26, is to be understood of any other position of the comet as well. For the sake of better understanding, however, we have likewise shown the parallax in these three drawings with the comet lying near the Pleiades, on the evening of December 24; in that position all these irregularities and reciprocations strike the eye no less, and most evidently. There, moreover, *e* represents the Pleiades, *f* the comet, *g* its true place, *i* the place of the comet at the first observation. What parallaxes the comet had at any time and at any altitude, in each of the figures about the Pleiades, the following little table shows.

Obser-vation	Hour	Altitude of the heel	Parallax, upper figure	Parallax, middle figure	Parallax, lower figure
1	6 in the evening	27°	5° 7′	2° 33′	55′ 42″
2	8	42°	4° 16′	2° 8′	46′ 27″
3	11	57°	3° 7′	1° 34′	34′ 3″
4	2 in the morning	42°	4° 16′	2° 8′	46′ 27″
5	5	15°	5° 32′	2° 46′	60′ 23″

[Margin: Si Cometa non altior Lunâ extitisset, pariter parallaxin diversorum horizontum ostendisset.] *If the comet had not been higher than the Moon, it would likewise have shown a parallax between different horizons.*

We have therefore shown, to the point of satiety, I think, and by various routes, that the comet was higher not only than the atmosphere (supposing it to extend to 20 miles), but also than a distance of 2580, 8600 and 17,000 miles, and indeed than the Moon itself, removed from us by 47,300; and this all the more clearly in that, even at this elongation, some parallax between different horizons is detected no less. Let us finally go on to seek it, too, between Danzig and Digne. Thus there are given:

Distance of the comet from the earth — 47,300 — m C

860 — A m

48,160 — A C — *from which let there be subtracted, p. 159,*

the side found, A n — 857 — *Subtr.*

The remainder will be the side C n — 47,303

Now therefore, as C n, 47,303 miles, is to 77 miles, n L, found on p. 159, so is the whole sine, 100,000, to the tangent of the angle n C L, 163, whose arc is 0° 5′ 36″; if this is doubled, the whole parallactic angle D C L becomes 11′ 12″, or the parallax H K itself.

[Margin: Cometa 1652 Lunâ longè superior.] *The comet of 1652 far higher than the Moon.*

Hence it is seen once again that at Digne the comet could in no way have been seen in a straight line with the two stars in the foot of Perseus, but must necessarily have shone there 11 minutes higher. It therefore stands unshaken that the comet carried on the regular course of its motion far above the Moon, in the highest ether: which is what was first to be demonstrated, in a general way, by these arguments.

[Margin: Parallaxes eruendimodum accuratiorem proponit Autor.] *The author sets out a more accurate method of finding parallaxes.*

But if anyone is perhaps not yet satisfied with these arguments, we shall try to weigh the matter still much more precisely and to bring everything under a more exact examination, and also to derive the parallaxes more skilfully; above all, to investigate carefully, in the most varied ways, whether our comet was subject to parallaxes, and to how great ones; and further, whether over the whole time of its appearance the parallaxes, always the same, remained; or

whether they varied continually, and how matters stood with that variation? For parallax is the one and unconquerable way to measure the distances of comets; if parallaxes are neglected and unknown, the true distance from the earth of any phenomenon, whether aerial or ethereal, is determined in no way at all.

[Margin: Nonnisi per parallaxes Cometæ locùs & distantia cognoscitur.] *Only through parallaxes are a comet's place and distance known.*

What kind of labour, and how great, it is to investigate everything thoroughly in this way and to bring it out properly, I leave to those more skilled in astronomical matters to judge. I do not doubt that all would admit it to be a work of great difficulty and immense labour, so that it is no wonder that even the ancients observed the parallaxes of comets little, as Cysat rightly says on comets, chapter 3, p. II, page 25.

[Margin: Parallaxes debitè elicere ingens labor est.] *To derive parallaxes properly is an immense labour.*

For this reason I too would almost have declined this task. But I reflected that only by this one method can that question of great moment, debated by philosophers for so many centuries past up to now, be settled altogether: namely, whether comets are generated in the highest, most limpid ether, within the regions of the planets and fixed stars, or whether, according to the Aristotelians, they move below the Moon, in the highest region of the air. I reflected, moreover, that this task (as Tycho argues in chapter VI, page 89, on comets) is the chief among those things that ought rightly to be said and inquired about comets, and without which all the rest that is put forward is defective. I have therefore taken up this charge most gladly. May God, Best and Greatest, grant that our efforts succeed as we wish, both to the glory of his name and to the advancement of astronomy and philosophy.

[Margin: Quid autorem impulerit ad parallaxes accuratiori modo indagandas.] *What drove the author to investigate parallaxes in a more accurate way.*

End of Book III [FINIS LIBRI III.]

Johannes Hevelius, Cometography, Book Four [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER QUARTUS.]

On the True Parallaxes of the Comet, Both Vertical and Horizontal, Investigated by a More Accurate Method [De genuinis Cometæ parallaxibus, tam verticalibus, quàm horizontalibus, accuratiori methodo, investigatis.]

[Margin: PerParallaxes præcipua quæstio de Cometis dirimitur.] *Through parallaxes the principal question about comets is settled.*

Now that we have come, then, to this most subtle business — the one on which alone turns the hinge of the whole dispute between the astronomers and the Peripatetics about the seat of comets, and from which, once it has been duly undertaken and carried through, arises that altogether irrefutable argument

about the true distance of comets from the earth — it will not be beside the point to review briefly in advance by what method these genuine and true parallaxes, whether vertical or horizontal, may be investigated as well and as accurately as is ever possible.

[Margin: Variâ viâ parallaxes inquiruntur.] *Parallaxes are sought by various routes.*

It is certain, indeed, that the ancients and the moderns have handed down many different methods of finding parallaxes; yet of these very few can be applied, above all to phenomena of the kind that exhibit a notable proper motion, as this comet of ours did. For it is rare that the observation itself yields, at one and the same time, as many data and of such kinds as are necessarily required, because of the various reasons and various hindrances that arise during observing. Moreover, the greater part of these problems are such that they can be constructed and demonstrated much more quickly and readily than they can be carried through and computed in figures complete in every respect — above all if the parallaxes amount to only a very few minutes. Among these the second problem of Regiomontanus is, not wrongly, counted.

[Margin: ModusRegiomontani lubricus.] *Regiomontanus's method is slippery.*

Although by everyone's account it is a very subtle discovery, yet for various reasons to be given below it is by no means suited to practice and calculation. And so, in this business, something is more easily said and proposed than accomplished in the work itself with profit and with the happiest result. Tycho Brahe speaks rightly and shrewdly on this matter in the *Progymnasmata*, Book I, on the New Star of 1572, p. 518: "Not all things that hold rightly in speculation about these matters are for that reason applied in practice free from suspicion of error; especially if you build great things out of the smallest, they for the most part waste their labour." Likewise in Book II, p. 157: "There are many things which, carried into speculation, can indeed stand correctly; but if the use of practice

[Margin: Non univerſa[[,/;]] licet in ſpeculatione rectè ſe habeant,ac demonſtrari poſſint, ad praxin deducuntur.] *Not all things, though they hold rightly in speculation and can be demonstrated, are carried into practice.*

you bring to bear, then even using the most exquisite instruments and lynx-like eyes (especially where the aim is directed at slender quantities, so that the greatest are built up on them), you will fall into inextricable absurdities." Further, in a certain letter, not yet published, against Craig the Scot [John Craig]: "For many things hold very well demonstratively which cannot, however, be brought into practice so conveniently — especially if such data [dedomena] are required that a slight error in them becomes, step by step in the working of the numbers, fruitful beyond measure."

[Margin: Exiguus error : nonnunquam maximum progignit.] *A slight error sometimes begets a very great one.*

The methods of computing the parallaxes of our comet that are more accurate and safer than all others — both by reason of its motion and by reason of our

observations — are the following: 1, by the apparent and true latitudes and declinations of the comet; 2, by the apparent and true altitudes of the comet; and 3, by the apparent and true distances from the fixed stars, whether observed or derived from altitudes, azimuths and the moments of time.

[Margin: Quinam modi parallaxes eruendi omnium ſint accuratiores.] *Which methods of finding parallaxes are the most accurate of all.*

Of these, however, the last method is certainly the safest and best of all, in the opinion both of Tycho and of all the modern mathematicians. Above all, if you undertake this task through distances observed with suitable and sufficiently large instruments, the work will certainly succeed much more happily than if you carry it out from altitudes, azimuths and the time — especially if the altitudes and azimuths were obtained with some smaller instrument and you have proceeded by the route of Regiomontanus. Tycho likewise judges this rightly in his letter to Rothmann, p. 295: "The method by distances, applied in due manner, is more certain than the one taken from altitudes and azimuths, in which a scarcely perceptible error becomes very fruitful; as these things are well enough known to you, who have handled them, and who have found out how easily one errs in altitudes and azimuths, but not likewise in distances." If you wish, you may read more on this matter in the same *Epistolae Astronomicae*, pp. 96 and 99, and also what Frommius set out at length against Morin [Jean-Baptiste Morin] in his astronomical dissertation.

[Margin: Per diſtantias, modus omnium eſt tutisſimus] *The method by distances is the safest of all.*

[Margin: Procliviùs in capiendis altitudinibus & Azimuthis,quàm diſtantiis Stellarũ aberratur.] *One errs more readily in taking altitudes and azimuths than in the distances of the stars.*

For my part I freely admit, together with those most distinguished men Tycho, Longomontanus, Frommius and Riccioli, that it is very true that one errs more readily and more easily in measuring altitudes and azimuths, and also in finding the true time, than in determining distances alone. And yet it cannot be denied either that parallaxes can be computed just as accurately through altitudes, azimuths and the true time — but on this express condition: that the azimuth quadrant [Quadrans Azimuthalis] be large enough, accurately divided into minutes and parts of minutes, and properly set on the meridian line; that the time be noted most accurately with sufficient circumspection, taken not only from ordinary clocks [automata], which Tycho mostly used, but by some other, infallible means, of which various routes are now open to everyone in this age of ours; and then that each and every thing be faithfully carried out by a most practised observer. Likewise, if you choose those altitudes which are free of refractions and not very near the meridian, and azimuths which are not too far from the meridian.

[Margin: Poſſunt etiam accuratè, ſuo tamen, modo parallaxes ex altitudinibus inveſtigari.] *Parallaxes can also be investigated accurately from altitudes, though in their own way.*

If all these things are so, I have no doubt that you will find the parallaxes most correctly, just as if you had gone to seek them through the observed distances themselves — especially if you use our method, to be described shortly. This will be explained at greater length in the *Machina Coelestis*, in connection with the quadrant and sextant and their use, and will also be demonstrated in its proper place, amply and more than enough, by a good many examples.

[Margin: Tycho autori adſtipulatur.] *Tycho agrees with the author.*

Moreover, Tycho did not altogether reject this method of investigating parallaxes through altitudes and azimuths. Together with us, he held only that it is more laborious, and a matter of greater skill, to derive parallaxes from observations of this kind; and further, that the greatest diligence is needed for these observations to be duly carried out — which, however, is by no means impossible for an observer who is well practised and equipped with suitable instruments. Accordingly the most praiseworthy Tycho also very often devoted himself to these observations and used them, except that he then noted the time much more diligently, as is clearly seen from his letters, p. 295: "Where I seek the comet's parallaxes from azimuths and altitudes, there I have not omitted to note not merely the minutes but also some fraction of them in seconds." Likewise in Book I of the *Epistolae Astronomicae*, p. 95: "With the armillary machines the true place of the star is shown to the very minute, agreeing entirely with the place that is obtained either through distances by means of the sextants, or else through azimuth quadrants turned with particular skill — especially if equal care is applied on both sides during the observing."

[Margin: Tycho per Azimutha frequẽter parallaxes deduxit.] *Tycho often derived parallaxes through azimuths.*

[Margin: Ad parallaxes perfectioribus inſtrumentis opus eſt.] *For parallaxes, more perfect instruments are needed.*

From this it follows that parallaxes require supremely accurate observations, obtained with an azimuth quadrant, or a sextant, or other more perfect instruments. For if you go astray with either this instrument or that, you will look in vain for anything accurate in this matter.

But, you will say, how then am I to be certain that the observations, each and every one, have been carried out as skilfully and as correctly as possible? I answer:

[Margin: Quænam circa parallaxium negotium notari debeant.] *What must be noted in the business of parallaxes.*

1. Never, indeed, trust one single observation, even if it was obtained by the most practised observer of all, with any instrument however perfect; much less presume to derive certain very great things from it, or to explore the subtler parallaxes. Rather, procure for yourself many different observations of every day.

[Margin: Non omnes obſervationes calculo parallaxium commodè adhibentur.] *Not all observations are conveniently applied to the calculation of parallaxes.*

2. Continue the observations from day to day, as far as can ever be done, and collect a great number of them; then from among them choose the more accurate ones, and those better suited to the business of parallaxes. For not all observations suit every time, every circumstance and the calculation, even when they have been carried out most correctly. Besides, it is altogether impossible to observe each and every observation always with equal diligence, because of various obstacles.

[Margin: Diverſis inſtrumentis obſervationes peragendæ ſunt] *Observations are to be carried out with various instruments.*

3. Carry out the observations not with one instrument only — whether a quadrant, sextant, octant, radius, armilla or some other instrument, however large — but with instruments of different kinds: now the radius (not that much is to be attributed to it, but for the sake of greater certainty), now the azimuth quadrant, now the sextant, or some other instrument suited to this business. For not all instruments can serve you equally well at once, at any time and place whatever, by reason both of the position of the phenomenon and of the observatory.

[Margin: Diverſa calculi methodus,ſecuriores reddit computatores.] *A varied method of calculation makes calculators more secure.*

4. Do not put your trust entirely in one calculation, nor in one method of computing parallaxes; rest content only at last, once they have been compared and tested by a good many examples and by various routes returning to the same calculation.

With all these things carefully attended to — that is, with observations by instruments of many kinds, with the greatest industry, by a most practised celestial investi- gator, collected into one bundle, the doubtful ones rejected and the more certain kept — and when each and every observation has then been subjected to a more precise calculation and worked out by a varied method, you will clearly perceive that from any observation whatever, drawn from the sky itself with this instrument or that and brought to the same time, the same calculation always comes out. From this you can be certain that no evident error has been committed, either in the observations or in the computations. But if the calculation reveals that the observations waver and fluctuate this way and that, and come out one way with the help of this instrument and another way with that one, you will easily conclude that the observations are doubtful and therefore to be rejected, and that nothing accurate is to be built on them.

[Margin: Quâ ratione omnis evidens error animadvertatur in eruendis paral- laxibus.] *How every evident error is detected in deriving parallaxes.*

For if everything is as it should be, then necessarily, from the quadrant as well as from the sextant or octant, and with every calculation duly made, every result will always be wholly equal to every other, or only a quite negligible small difference will be noted. For it can never at all happen that, in so many observations obtained with the most diverse instruments and worked out by so very diverse a calculation, we have been deceived in one and the same way, so

that the products of the calculation agree entirely, almost in the same minutiae of the seconds. Therefore, if you find in actual fact, as we have just said, that the quantities sought from all the data — taken from any observations whatever and obtained in any way whatever — correspond both to the time and to the motion, by reason of increase as well as of decrease, then certainly full trust is to be placed both in the observations and in the calculation.

[Margin: Autor quâ ratione Cometam infectatus eſt.] *By what method the author pursued the comet.*

In this way, then, we too set about our comet, both to investigate the parallaxes the more accurately and to satisfy all the more the lover of the stars who desires the truth. So from the very first day of the phenomenon's appearance right up to the last, not content with one or two observations of it, I made as many as the circumstances of the time, the clearness of the sky and its face ever allowed me — not only with our azimuth quadrant, very accurately constructed, but also with the sextant, and sometimes even with the radius. I attribute little to the radius, however, in the business of parallaxes, and I did not use those observations where others were at hand. Then, for the sake of greater certainty, and to win the minds of our opponents over to us all the more, I went to seek the parallaxes of the phenomenon itself from those various observations, by the most diverse method, as diligently as could be done.

[Margin: Autor quâ via parallaxes inquiſiverit.] *By what route the author investigated the parallaxes.*

First, from December 23 (for on the 20th it was not yet granted to draw accurate observations from the sky), I investigated them through the distances of the phenomenon from the fixed stars, observed ones where any were granted, and if not, through distances computed in due manner from altitudes and azimuths. Second, through the true and apparent altitudes of the comet. Third, through the true and apparent declinations and latitudes. And fourth, by the method of Regiomontanus. But just as this fourth is the last of all, so the first is certainly the most certain and most accurate of all. Accordingly I also examined the greatest part of the parallaxes by that route, and omitted nothing there that I judged to bear on a more precise and more accurate investigation of them, as the matter itself will show. Moreover, I adopted such methods of calculation — especially concerning the distances of the phenomenon and of the fixed stars lying both near the comet's orbit and at a right angle to the comet and its orbit, and concerning the assumed parallaxes [fictas parallaxes] to be derived from the equated distances [coæquatis diſtantiis], and these to be reduced to the vertical, and also concerning the first and second prosthaphaereses of inclination [proſthaphæreſes inclinationis], to be duly worked out — methods such as, I know very well, no one has used until now, be it said without boasting.

[Margin: Deductis parallaxibus Autoris methodo omninò demonſtrativè ſedes Cometarum exploratur.] *When the parallaxes are derived by the author's method, the seat of comets is investigated wholly demonstratively.*

These methods of computing the true and genuine vertical parallaxes, just as they are applied very fittingly to our comet, so also properly suit the other phenomena; so that by this method we can not only pronounce, as a probability and in Tycho's manner, that comets move above the Moon, but also always argue demonstratively about the true position and seat of comets.

But let us approach the matter itself, beginning by investigating the parallaxes through distances from certain fixed stars, in such a way that first the apparent motion of the phenomenon is duly examined, then its true motion, and lastly the equations and prosthaphaereses. Before we may arrive there, however, I consider it worthwhile to set out clearly each and every thing that must be known beforehand in this business and noted with the greatest care, so that no one fails to understand everything correctly and to penetrate it thoroughly. For this matter is not so easy to grasp and to demonstrate. Indeed, I am not afraid to say that not even those who persuade themselves that they have cultivated astronomy somewhat more deeply will grasp correctly, at the very first glance, everything that pertains here; rather, they too will very greatly need to consider and examine what is to be said with a mind properly intent and not flitting, before they grasp the whole matter perfectly. For this study of parallaxes, above all those of comets, is very nearly the most subtle, most intricate and most difficult of all astronomical matters.

[Margin: Antequam parallaxes aggredimur, opera danda eſt, ut omnia & ſingula rectè intelligantur; cùm res ſit perquàm difficilis.] *Before we approach the parallaxes, care must be taken that each and every thing is correctly understood, since the matter is very difficult.*

[Margin: Autor ſupponit Lectores Scientiæ Aſtronomicæ haud prorsùs ignaros] *The author supposes his readers not altogether ignorant of the science of astronomy.*

Hence, at the outset, before we come down to the particular points to be noted and to the preliminary notions, I suppose that all those readers of this work of mine who are lovers of mathematics already understand what parallax is and of how many kinds, and also have a true knowledge of those general axioms. But since these things are not yet sufficient, we must set out here in advance certain particular axioms and theorems about comets; if these are neglected, the work will be attempted in vain.

[Margin: Theorema parallaxium primum.] *First theorem of parallaxes.*

1. It must be understood that the distance from some fixed star (but taken free of refraction) of any phenomenon lacking all proper motion and parallax — in whatever place in the sky and in whatever position, whether the fixed star is below, or above, or under one and the same vertical as the phenomenon, or removed from the vertical point [puncto verticali] by a space equal to the phenomenon's, or is also inclined in various ways to the equator and the ecliptic — that distance, namely of the phenomenon and the fixed star, is then always of one and the same magnitude at any time whatever. This is quite evident in the intervals of the fixed stars,

whose separation from one another is perpetually the same, provided you measure it accurately.

[Margin: Theorema ſecundum.] *Second theorem.*

2. The distance from a fixed star of a phenomenon that has parallax, even if it is devoid of all proper motion, changes from time to time (even if you remove refraction entirely from both bodies); and it changes more or less in proportion to its greater or lesser altitude above the horizon, and also according to whether the phenomenon is higher or lower than the fixed star, and the line of distance slopes toward the horizon at this or that angle of inclination.

[Margin: Theorema tertium.] *Third theorem.*

3. A phenomenon free from all proper motion but subject to parallax, and placed under one and the same vertical as a fixed star, varies greatly the distance between itself and the fixed star; but very little (if the parallax is small), indeed almost not at all, if the phenomenon and the star are equidistant from the vertical point, or are removed from the horizon by an equal interval; so that the apparent and the true distance are then quite the same.

[Margin: Theorema quartum.] *Fourth theorem.*

4. But if the phenomenon has a proper motion tending upward toward the zenith, and cuts the ecliptic with its orbit at a certain angle, and also possesses parallax, then the observed distances change all the more, the swifter the proper motion is and the higher or lower the phenomenon is with respect to the horizon; whether it stands above or below the fixed star, or inclines to this side or that. And this holds above all if the said distances appear greater and smaller according as the phenomenon is approaching the fixed stars or receding from them.

[Margin: Infallibilis conſequentia.] *An infallible consequence.*

From this it follows that, when a phenomenon has no proper motion but a definite parallax, and stands under one and the same vertical with a lower fixed star, the earlier and lower observed distance is smaller than the other, later and higher one, taken after one or two hours have elapsed, because the earlier parallax is greater and the later one smaller. But with the phenomenon placed below the fixed star, the earlier distance turns out greater and the other smaller, if both bodies are in the eastern quarter and ascending; if, however, the phenomenon and the fixed star are in the western quarter and descending, you will find the contrary. In these cases, therefore, when one distance is subtracted from the other (the altitude of the phenomenon at each observation being known), there remains the difference of parallax of the two given altitudes.

[Margin: Negotium parallaxium longè aliter ſe habet, ſi phænòmenũ, cum motu proprio, ſimul parallaxin poſſid[[e/è]]t.] *The business of parallaxes is quite different if the phenomenon possesses parallax together with proper motion.*

But when the phenomenon exhibits parallax and proper motion at once, this business becomes much more intricate, and then the observed distances

vary in a quite different way — indeed, by reason of the phenomenon's proper motion relative to the fixed star. Hence, if you want the parallax of such a phenomenon, you must necessarily have its proper motion known. When this has been either subtracted from the earlier or the later distance, or added to the other, as the case requires, the difference of the two distances — namely of the one equated and of the other bare — gives the assumed or mean vertical parallax of the phenomenon: that is, if the phenomenon and the fixed star are under the same vertical in one of the two observations, and at the same time the fixed star is very near the orbit, or is found right under it. The matter also comes to the same thing when you take the true proper motion away from the apparent one, or from the difference of the bare distances: the assumed or mean parallax itself results.

[Margin: Quando diſtãtia reducenda ad orbitam & verticalem.] *When the distance is to be reduced to the orbit and to the vertical.*

But when the fixed star is somewhat distant from the orbit of the phenomenon — for example, of ours (for in others the matter can stand one way or another, according to the position of the orbit) — we need a certain equation: namely, by reducing one of the two distances to the orbit, so that the parallax of the orbit results. Indeed, if we look into the matter more deeply, that parallax must in turn be reduced to the vertical, and likewise the prosthaphaeresis of inclination, both the first and the second (about which you will learn more presently), must be applied to it, so that at last the pure and genuine vertical parallax itself, equated a second time, may be drawn out. Otherwise, indeed, it is spurious and adulterated — that is, not purely and simply vertical, but mixed with the parallax of longitude, latitude, declination and right ascension; although sometimes all those equations scarcely run to a few seconds.

[Margin: Quando vicisſim nullâ reductione opus ſit.] *When, in turn, no reduction is needed.*

Furthermore, when the fixed star stands at exactly a right angle to the phenomenon and its orbit, no reduction at all is needed (saving, however, the remaining equations and prosthaphaereses); the proper motion is simply either added to one of the distances or subtracted from it, according as both distances were observed in the same quarter of the sky, east or west, or in different quarters. Unless perhaps the fixed star does not fall precisely at a right angle with respect to the phenomenon and its orbit — as indeed usually happens — but at a certain angle of inclination: then one must likewise use the reduction mentioned above, or the equation to the orbit, though it is to be found by a particular method. This will be treated more fully in connection with the calculation itself, so that I do not, as it were, overwhelm the reader at the outset by delivering too many intricate things at once. So let these remarks suffice, such as they are, which we have just set out in general terms and briefly.

[Margin: Si nullus non hocce negotium parallacticum rectè intelligere debet, adhuc fuſiùs id ipſum pertractandum erit.] *If no one is to fail to understand this parallactic business correctly, it will have to be treated still more fully.*

But perhaps I seem to have dwelt too long on these preliminaries, and to have brought in more than I ought. Yet so far am I, my lover of the stars [mi Aſtrophile], from seeming to have satisfied myself — let alone you, who are perhaps still less practised in astronomical matters — that I rather think a great many things remain to be said, if this parallactic business is to be understood clearly and thoroughly by anyone at all without distinction. For it is not only arduous; cases of many kinds also sometimes arise from the most diverse situations of comets, which can almost overturn the whole matter — as this comet of ours will testify amply and more than enough. Not to mention that, if everything that has been said were to be applied to any phenomena whatever, past as well as future, a separate little book would certainly have to be composed; and neither the time nor our purpose permits that. Nevertheless, so that this matter, for whose sake we took upon ourselves this whole uncommon labour, may be grasped sufficiently and thereby be made clearer and more evident to all, we shall direct everything that follows, as regards both the axioms and the analyses, chiefly to our comet. Moreover, with an accompanying diagram [appoſito Schemate] we shall demonstrate how parallaxes must be exactly derived from the distances of the phenomenon from a fixed star.

[Margin: Quâ ratione ex diſtantiis phænomeni à fixâ, parallaxes erui debeant.] *How parallaxes must be derived from the distances of the phenomenon from a fixed star.*

These, no less than each of the foregoing, can, I believe, be applied fittingly and with great profit to very many other phenomena that exhibit a proper motion.

In the accompanying diagram, let O K P be the horizon, O R P the equator, R Q the ecliptic, F K the meridian; the remaining arcs of circles, descending from F, the point of the zenith, to the horizon, are verticals; G H is the orbit of the comet, A Aldebaran, B the Heel [Calcaneus] or Algol, D Capella, E the Bright Star of Aries [Lucida ♈], C the comet, S Regel. On the left is the configuration of the eastern quadrant of the sky, and on the right that of the western quadrant — that is, the way in which the same stars present themselves to view in each position after a certain lapse of time. But before we proceed with this analysis, it will be useful, for the sake of greater clarity, to set out certain preliminary warnings.

[Margin: Præmonitiones quædam circa parallaxes valde notabiles] *Certain very noteworthy preliminary warnings concerning parallaxes.*

It is therefore to be noted: 1. If you wish to examine parallaxes from distances, you must have at hand two different distances found at different times, whether they were observed with the sextant and the octant, or, from the altitudes, the azimuths and the true time that elapsed between the two observations, the longitudes and latitudes du- ly computed, or whether the apparent distances themselves were afterwards derived from these, it will come to the same thing, provided you have carried everything out accurately and diligently; as will also be manifest from the following examples.

Diagram. An engraved figure in a rectangular plate-mark, uncaptioned, set across the text column between lines 5 and 6 of the page. It is a dome-shaped projection of the sky: the horizon is the curved base, running from P at the left to O at the right, with the foot points I, H, K, L, M and N marked along it, and labelled *Horizon.* on each side. F at the top is the point where the verticals meet; the straight vertical *Meridianus:* ("Meridian") runs from F down to K. The left half shows the eastern configuration (*Oriens*, "East") and the right half the western (*Occidens.*, "West"). In the left half the comet's orbit is a near-vertical line from G at the top down to H on the horizon, labelled *Orbit. Comet.* in its upper part and *Orbit. Com.* in its lower part ("orbit of the comet"); on or beside it stand the star B, *Algol vel Calc.* ("Algol or the Heel"), the comet C, *Cometa C*, drawn as a hatched disc, and the star A, *Palilic.* ("Palilicium"); to its left is the star D, *Capella*, and to its right the star E, *Lucid.* ♈. ("the Bright Star of Aries"); the ecliptic, *Ecliptica.*, runs from the sign of Cancer at the left edge to the sign of Cancer at the meridian; the equator, *Æquator.*, rises from P; the star S, *Regel.*, stands near the foot of the orbit line, beside a further vertical that ends at I. In the right half the orbit runs from H on the meridian up to G at the right edge, labelled *Orbita* and *Cometæ* along it; on it stand the comet C, *Comet*, drawn as a hatched disc, and the star B, *Algol.*; the star A, *Palilio.*, stands on a vertical below the ecliptic; the star E, *Lucid.*, and the star D, *Capella*, stand among the verticals; the ecliptic, *Ecliptica.*, runs from the meridian down to R at the right edge; the equator, *Æquator.*, runs from a point R beside the orbit down to O; verticals from F meet the horizon at L, M and N. Below the frame at the right: *Autor ſculpſit.* ("The author engraved it"). Every label is listed below as read; none is supplied from the text.

- Top: G; F
- Left half: *Orbit. Comet.*; *Meridianus:*; *Algol vel Calc.* B; D *Capella*; *Cometa* C; E *Lucid.* ♈.; *Ecliptica.*; the sign of Cancer (twice: left edge and meridian); *Palilic.* A; *Æquator.*; *Regel.* S; *Oriens*; *Orbit. Com.*; P; *Horizon.*; I; H
- Centre: H (on the meridian, at the foot of the western orbit); K
- Right half: *Capella* D; *Ecliptica.*; *Comet* C; B *Algol.*; G; *Palilio.* A; *Cometæ*; E *Lucid.* [?]; R (beside the orbit); *Orbita*; *Æquator.*; *Occidens.*; R (right edge); O; N; M; L; *Horizon.*
- Below the frame: *Autor ſculpſit.*

[Margin: Ex quibus obſervationibus genuinæ parallaxes verticales [eruantur?].] *From which observations the genuine vertical parallaxes are derived [?].*

Secondly: let both apparent distances of the phenomenon and the fixed star be given either in one and the same quadrant, eastern or western, or the one in the western quadrant and the other in the eastern, or vice versa, if you are endeavouring to elicit parallaxes. From the former case, however, only the difference of parallax of the two altitudes is found, if the comet and the fixed star stand at the same time exactly under the same vertical. Since this, however, seldom happens so precisely, the assumed parallax is here for the most part

reduced to the vertical by a new method devised by us. In the latter case, by contrast — that is, from distances found in different quarters of the sky, the one in the east and the other in the west, or the reverse — the work succeeds far more accurately and more happily. For from these you will learn the genuine vertical parallaxes themselves: above all if you take care to see the comet and the fixed star in the same quadrant and at the same time under one and the same vertical, and in the other, opposite quadrant to observe the line of distance — namely of the comet and the fixed star — roughly parallel to the horizon. Thus from the earlier observation, with the comet and the star placed under the same vertical, you will have a merely apparent distance, in which the parallax itself lies hidden; but from the later one, with the distance parallel to the horizon, you will have the apparent and the true distance at once. For in that position the parallax can by no means appreciably corrupt the distance; in the earlier one, on the contrary, it does so as much as possible. Hence, when one distance is subtracted from the other (but with one of the two first corrected by the true proper motion), the vertical parallax itself will result.

[Margin: De parallaxi fictâ atq; proſthaphæreſi inclinationis.] *On the assumed parallax and the prosthaphaeresis of inclination.*

But if one distance has been found not exactly under the same vertical, and the other not entirely parallel to the horizon — as usually happens — then the assumed parallax, or equal parallax, or parallax of the orbit, is to be reduced to the vertical, and the prosthaphaereses of inclination applied to it, so that the true vertical parallax may become known: as we have already touched on somewhat above, and shall also demonstrate below to the eye.

But let us return to our diagram, from which the matter will become much clearer.

[Margin: Parallaxis diſtantiam à fixâ reddit majorem, ſi fixa altior exiſtat phænomeno, ſub eodem verticali.] *Parallax makes the distance from a fixed star greater, if the fixed star stands higher than the phenomenon under the same vertical.*

Let C B be the earlier distance, of the comet and the Heel — the star very near to the orbit — found in the eastern quadrant, and at a time when both stood roughly under the same vertical, yet in such a way that the fixed star claims the higher place. In this case, therefore, the parallax, if there is any in the observations, depresses the comet toward the horizon according to its nature and magnitude, so that this distance B C is rendered greater, by reason of parallax, than it really would be if the comet lacked all parallax — in accordance with Axiom 3, given above. And hence B C becomes the apparent distance itself, in which the parallax lies wholly hidden. That parallax would easily become known if the true distance, known for the same time, were subtracted from this earlier apparent distance B C.

[Margin: Quâ ratione vera diſtantia inveniatur ac corrigatur.] *How the true distance is found and corrected.*

But by what means that true distance is to be found, and rectified with the help of the true proper motion, we shall now teach.

Now, just as it is necessary that one distance of the comet and the fixed star, C B, be known in the eastern quarter under the same vertical, so also the other — in the western quadrant, roughly parallel to the horizon, that is, when the comet and the fixed star are removed from the vertical point by an equal interval — is required above all.

[Margin: Diſtantia horizonti parallela ſimul viſa & vera eſt.] *The distance parallel to the horizon is apparent and true at once.*

For this latter one, as is clear from the preceding diagram to anyone who considers the matter somewhat more attentively, is at once the apparent and the true distance, and entirely free from all parallax, according to Axiom 3. For that distance — namely when the comet and the fixed star are equidistant from the horizon — is not distorted even in the least, even if some parallax is present: unless perhaps the parallax is very large, namely of several degrees; and even supposing it to be so large, the difference will still scarcely extend to a very few minutes.

[Margin: Quo in loco parallaxis in perceptibilis ſit.] *In what position parallax is imperceptible.*

The reason is this: although the comet in that position is depressed from its true place toward the horizon by reason of parallax just as before, nevertheless, despite that depression, the distance C B (namely in the western quadrant, where the Heel B is removed from the horizon right at the comet's side and equally with the comet) is in no way varied. And even if you were to grant that it varies, the change is still by no means so great that it could be perceived, or that anything could thereby be taken away from the parallax even in the seconds. Indeed, suppose the parallax to be a whole degree, and the distance at the same time to be twenty degrees and more, or even 30: you will still barely, if at all, notice a difference of one minute. From this one may judge how small the difference would be if the parallax amounted to only a few minutes (as can be seen in our comet): it will then surely show us a difference of scarcely one or two seconds.

[Margin: Diſtantia ſub eodem verticali obſervata, viſa tantummodò eſt.] *The distance observed under the same vertical is only apparent.*

Since this is so, the distance parallel to the horizon, as seen, is always also the true one; while the vertical distance, observed under the same vertical, represents only the apparent one, to which the parallax plainly adheres, and in which the parallax, if any is present, is detected as perceptible. Therefore, when the one is simply taken away from the other, there remains the parallax sought itself: provided that the comet is driven by no other motion than the first motion.

[Margin: Diſtantiæ [[;/,]] ratione motus proprii corrumpuntur.] *The distances are corrupted by reason of the proper motion.*

But since our comet possesses a notable proper motion, as was shown at length in the foregoing, that later distance parallel to the horizon is vitiated. Accordingly, this proper motion, accomplished between the two observations,

must be separated from one or the other of the distances, by addition or subtraction according to the phenomenon's approach or recession, so that one or the other distance may become known as true. Then, in turn, take the one away from the other, as we have just said, and you will have the parallax itself.

[Margin: Multùm intereſt cognoſcere, an Cometa, ratione fixæ alicujus, in acceſſu, an verò in receſſu feratur?] *It matters greatly to know whether the comet is moving in approach or in recession with respect to some fixed star.*

In this operation, however, I would have you note above all in which direction the comet holds its own proper course: whether, with respect to the fixed star, it is moving in approach or in recession. And since it is certain that our comet always directed its path upward, toward the zenith, from the Hare [Lepore] through the equator and the ecliptic toward Cassiopeia, the said comet certainly became gradually nearer to the Heel (namely in the first days of its appearance; in the later days the contrary happened), and was in approach, at that time in the eastern quadrant, always lower than the fixed star; and so, as a consequence, that later distance parallel to the horizon was notably diminished in the interval that elapsed between the two observations.

[Margin: Quomodo parallaxis orbitæ innoteſcat.] *How the parallax of the orbit becomes known.*

Therefore the proper motion of the comet that correctly corresponds to the given time elapsed between the two observations, taken from our table often mentioned, inserted in Book I, Section X, page 109 [Lib.I Sect. X pag.109], should be added to the later, parallel distance — or, what is the same thing, taken away from the earlier distance — so that one of the two is reduced and transformed into a true distance with respect to the other, apparent one, just as if the comet had been subject to no proper motion. Afterwards, when the one is taken away from the other — namely the apparent from the true, or vice versa — the parallax of the orbit springs out: on this condition, however, that the fixed star stands either under the comet's orbit itself or very close to it; if not, the said fixed star is first to be reduced. But how this investigation ought to be conducted it is not fitting to say at present, lest I overwhelm the reader's mind with more than a great many most abstruse things, and perhaps draw his attention away from the matter taken up earlier and not yet finished; we reserve it for another time, in connection with the presentation of the calculation itself.

[Margin: Diſtantias ab omni motu proprio liberare.] *To free the distances from all proper motion.*

Besides this way of stripping one or the other distance of all motion, there remains another to be described, which I have used not infrequently. Take one bare distance away from the other bare distance, and the difference will show you the apparent proper motion of the comet — a mean, as it were, or assumed motion, corresponding to that particular time. From this, in turn, subtract the true apparent proper motion of the comet taken from the table for that time, and the genuine parallax sought will result: that is, when there is no need of reduction to the vertical, nor of the prosthaphaereses of inclination. Otherwise

the parallax found is only mean and assumed, and always fits only that altitude — which you should note well — at which the comet stands together with the fixed star under the same vertical; but it by no means fits the other altitude, when the distance was parallel to the horizon, since that distance is almost free, as far as parallax is concerned, of all variation.

[Margin: Quando motus viſus vero major eſt.] *When the apparent motion is greater than the true.*

Moreover, I think it should be pointed out here that, when the comet is moving in approach to the Heel, the apparent motion is always greater than the true one, if there is any parallax in the observations: that is, if the fixed star is found either under the orbit itself, or very near to the orbit and the vertical. But if the fixed star is removed from the orbit and the vertical by a notable space, know that the contrary happens, and the apparent proper motion is smaller than the true one. I shall deal with these matters more fully shortly, and shall set out definite axioms by whose help the whole matter can be settled with the greatest ease. And let this suffice about this method of investigating parallaxes when our comet in particular is moving in approach to a fixed star and at the same time sits near the orbit together with the fixed star.

[Margin: Ratio parallaxes inveſtigandi quando Cometa ad Stellam in receſu verſatur.] *The method of investigating parallaxes when the comet is moving in recession from a star.*

Conversely, when the comet — in the earlier, eastern observation, that is — stands under one and the same vertical as a fixed star, such as Palilicium A or Regel S, or not far from it, and is in recession from the star, namely gradually receding from it, the true proper motion is taken away from the later distance, the one parallel to the horizon, or added to the earlier one. Afterwards the difference of the two distances yields an assumed, or equal, parallax.

[Margin: Regulæ benè notabiles.] *Rules well worth noting.*

In sum: whether the phenomenon is above or below the fixed star, provided it is in approach, the true proper motion is always added to the later distance parallel to the horizon; but in recession it is subtracted from that same later distance. Or vice versa: in approach the true proper motion is taken away from the earlier, vertical distance, and in recession it is added to that same distance. The matter comes to the same thing, as we have already touched on, if the comet is in recession with respect to the fixed star: then the difference of the bare distances, or the apparent proper motion, is likewise always greater than the true proper motion — but only in those cases when the fixed stars from which the distances were taken are seen either under the comet's orbit itself and under the same vertical, or very near to these, or at least not very far from them, namely in the earlier, eastern observation; and when at the same time, in the later, western observation, the fixed star and the comet are at exactly equal distances from the horizon, or the fixed star is a little less — that is, somewhat lower. Then, I say, the apparent proper motion is always greater than the true one. But if the fixed star is higher than the comet, the whole business is

reversed, as will be explained shortly afterwards, once the things that must be set out first have been dealt with.

[Margin: Quando motus proprius viſus vero major eſt.] *When the apparent proper motion is greater than the true.*

But when the fixed star, with the comet receding from it more and more, does not stand exactly under the same vertical (namely in that region of the sky in which this ought rightly to happen) nor near it, but is removed by a fairly large interval, so that the comet and the fixed star must pass through two very different verticals, one each, forming a quite notable angle at the zenith [ad verticem]; and so that likewise the angle formed by the comet's vertical and the line of the distance to the comet is still greater and more obtuse (such an appearance, namely, as Aldebaran presented to us with the comet in the first days of its appearance, and Algol in turn with it in the later days, when the comet was higher than the fixed star and receding): in that case the apparent proper motion is always greater than the true one, if there is any parallax in the observations.

Certainly, hardly everyone will persuade themselves of this, since the matter is very difficult to grasp, and moreover in itself quite hidden and intricate, so that it can hardly be unravelled in a few words. I shall nevertheless labour, as far as I can, to set the matter out and demonstrate it graphically to any attentive reader. For it matters greatly to the attainment of our end that everything be correctly understood, both for other purposes and also for understanding the prosthaphaereses of inclination. Believe me, without knowing these, it is wholly impossible to penetrate the properties of those prosthaphaereses — namely, in what way they are to be applied to parallaxes reduced to the vertical.

[Margin: Quâ ratione proſthaphæreſes parallaxibus ſint applicandæ graphicè declaratur.] *How the prosthaphaereses are to be applied to parallaxes is set out graphically.*

In the following figure let there be the vertical point; A C D S and A B, verticals; B, Aldebaran; C, the comet in the earlier observation; F, the comet in the later observation; the line B D parallel to the horizon; and B C the distance of the comet and Aldebaran. Now we said, in the explanation of the preceding diagram, that when the comet is higher than the fixed star and in recession, and both then stand exactly under the same vertical in the earlier observation — as here the comet C and Regel S — the parallax depresses the comet toward the horizon and makes that earlier distance C S smaller, but makes the apparent motion, between the comet's first station and F, the second, greater.

Diagram. An engraved figure beside the opening lines of the page. Three curved lines descend from A at the top to a curved horizon at the foot: a left arc, a middle arc passing through the star B, and a line passing in turn through F, E, C, D and S; a fourth arc descends from A on the right to the horizon. Straight lines join B to C and B to D; a dotted arc runs from near B up to E, and a dotted line from C down to G. Labels as read on the figure:

- A (top): A

- F (upper middle, on the right-hand line): comet symbol, with "Cometa." *comet* on its left
- E (on the same line, above C): E
- C (on the same line): comet symbol, with "Cometa." *comet* on its right
- B (left of centre, on the middle arc): star, with "Palilit" on its left — so engraved, seven letters; the star the text calls Aldebaran
- G (below the line B D, left of the right-hand line): G
- D (on the right-hand line, at the end of the line from B): D
- S (lower middle, on the right-hand line): star, with "Regel." on its left
- Horizon (lower centre, on the horizon curve): "Horizon." *horizon*
- Below the frame, lower right: "Aut. ſculps." *the author engraved it*

No letter other than A stands at the top of the figure, where the verticals meet, and the text of p. 225 gives the vertical point no letter.

For in recession the earlier distance is smaller than the later one, and besides, that earlier distance is made still smaller than it really is in itself; so certainly, when the one is taken from the other, that difference of the distances, or the apparent motion, becomes greater than the true — namely around those fixed stars that stand under the same vertical as the comet in the earlier observation and are equally removed from the horizon in the later observation. For by the depression of the comet C toward the fixed star S, that distance is diminished.

[Margin: Quando motus viſus, vero minor eſt.] *When the apparent motion is smaller than the true.*

But when the comet and the fixed star are found in the earlier observation under two very different verticals forming a notable angle — such as Aldebaran at B and the comet at C — so that the vertical A C makes a quite obtuse angle with the line of the distance C B (an angle which in the earlier case, under the same vertical, vanished entirely, as is clear from the distance C S of the comet and Regel): in such a configuration, I say, exactly the contrary happens. For although the comet C is truly higher than the fixed star B and the line parallel to the horizon, and on this basis the comet is depressed by reason of parallax toward the fixed star and the line D B parallel to the horizon, the earlier distance does not for that reason always turn out smaller, as happens with Regel S and the comet C under the same vertical; but not infrequently it is even greater.

For if you drop the perpendicular B E from the fixed star B onto the comet's vertical, it necessarily falls, as is known, exactly at a right angle. Hence all the other lines proceeding from the fixed star B to the comet's vertical, whether they are higher or lower than C, are necessarily always greater than the perpendicular B E, according to Euclid, Theorem 21, Proposition 19 [Theor. 21 Prop. 19], and the corollary of Clavius [Christoph Clavius] to the same proposition, where it is demonstrated:

[Margin: Linea perpendicularis omnium breviſſima eſt.] *The perpendicular line is the shortest of all.*

Of all straight lines drawn from any point to any straight line whatever, the one that is perpendicular is the least. From this it follows that, as long as the comet sits

above the perpendicular line B E, so long does the parallax make the distance C B smaller, and consequently, in the said case, the apparent motion greater. But when the comet C stands below the perpendicular line B C (as mostly happened in our calculation, to be appended, around Aldebaran, Algol and the Heel, while the comet was moving in recession), the parallax, by depressing the comet toward the fixed star B and the line B D parallel to the horizon, no longer makes the distance B C smaller, but greater. For all lines falling below the perpendicular continually increase, according to the theorem just cited. Besides, the parallax depresses the comet not along the perpendicular line E G, nor in the same vertical, but in a different vertical A C D, inclined to the line B D, toward D.

[Margin: Regulæ pro parallaxibus.] *Rules for parallaxes.*

Hence, when the comet stands above the fixed star, and both are under one and the same vertical, and the fixed star is under the orbit itself, the apparent motion is indeed always greater than the true; but not always when the comet, though above the fixed star, is moving with each under its own vertical. Rather, the apparent motion is greater than the true only at that time when the comet is found to be also above the perpendicular line B E drawn from the fixed star B to the comet's vertical. But when — note well — the comet already lies on the perpendicular line B E itself, or somewhat below it, the apparent motion, I say, is smaller than the true. This almost always happened in our calculation around Aldebaran, Algol and the Heel, while the comet was in recession; and for this reason the apparent motion was then indeed always smaller, if there was any parallax.

Moreover, it also often happens that the comet in the western region (where the distance is supposed to be equidistant from the horizon) is not removed entirely equally with the fixed star from the zenith point, or from the horizon, nor stands somewhat below it, but is rather raised a little higher; and besides, that it is lower in altitude in this later, parallel observation than in the earlier, vertical one — as in the example of the following investigations, undertaken from the distances of the receding comet from Palilicium, the Heel and Algol. And then — which I would have you note very well — even supposing that you place the fixed star in the earlier, vertical observation, namely in the eastern region, and the comet nearly under the same vertical, indeed under that very vertical, the apparent motion is nevertheless always smaller than the true, if any parallax lies hidden. This is in exactly the contrary way, as we have already mentioned, from when the comet and the fixed star are under the same vertical in the earlier, eastern observation, and in the later, western observation are either equally removed from the horizon, or the comet is a little lower than the fixed star.

The reason is this: in the comet's recession from the fixed star, the apparent motion in this later, western observation — in which the distance is greater than the earlier one — is always altered, and is shown smaller than it would really have been if the comet and the fixed star had been equidistant from the horizon,

or the comet had been placed a little below the fixed star. This is not only because the comet stood above the fixed star in the later, parallel observation, but because in this observation the comet, with respect to itself and to the earlier observation in the eastern quadrant, was much more depressed in altitude.

[Margin: Hocce negotium ut admodum intricatum eſt,ſic maximâ attentione opus habet.] *As this business is very intricate, so it needs the greatest attention.*

But in the comet's approach to the fixed star, even though a higher place is assigned to it in the later, western, parallel observation, the things that have been said are so far from being able to vitiate the apparent motion that I rather think the apparent motion will be smaller when the comet is lower than the fixed star. This, certainly, is extremely difficult to understand, not only in my judgement but perhaps in that of others as well: above all because cases of many kinds occur, and to elucidate each and every one of them sufficiently, and reduce them to definite general axioms, would be too lengthy a business. But if you set the comet and the fixed star under one and the same vertical in the earlier observation, and again at equal distances from the horizon in the later one, everything can be bound by the most certain rules, which will be added at once; although we shall also strive to be able to refer all those cases which our calculation of parallaxes contains to definite classes and axioms. But the axioms of the remaining cases, if any remain, by those who excel in ingenuity and are endowed with keen and refined judg- ment, will, I hope, be constructed without very great difficulty when they need them, provided they direct their minds solely to this matter.

[Margin: Ex quibus certò cognoſcitur phænomeno ineſſe parallaxin] *From which it is known for certain that there is parallax in the phenomenon.*

Meanwhile, keep this for yourself by way of a supplement [mantiſſæ loco]: it makes no difference whether, at the very start of the calculation, you know or do not know whether the apparent motion ought to be greater or smaller than the true, if there is any parallax in the observations. But as soon as you notice that the difference between the distances reduced to the orbit is greater than one or two minutes, presuppose that parallax is present and continue the calculation; provided you rely on more accurate observations, you cannot be deceived. But if you find the difference of the corrected distances to be smaller than one or two minutes, or of only a few seconds, you must look into the matter more deeply. And if you cannot do this, I would have you consider another example, in which the fixed star viewed the comet and its orbit at a right angle. From that, I say, I hope you will be helped not a little, and will at once perceive whether there is any parallax or not. For those cases can be defined far more accurately, and contained and set out in fewer axioms, which will be brought forward in due time.

[Margin: Animadvertenda, quando Fixa Cometam ejusq; orbitam ad angulum normalem adſpicit.] *Points to be noted when the fixed star views the comet and its orbit at a right angle.*

This is roughly what we had to say about the case when the fixed stars from which the distances were taken are placed either under the comet's orbit itself or not far from it. It follows that we should also set out briefly the other business: when the fixed stars are seen at exactly a right angle [ſub normali angulo] to the comet and its orbit. There the matter stands very differently, as can be clearly seen from the earlier figure set beside the text. In it Capella D (as was also done in our observations around the Bright Star of Aries and the bright star of the side of Perseus [Lucidam lateris Perſei]) sits in the eastern quadrant exactly perpendicular to the comet C and its orbit E C G, together with the comet, on a line roughly parallel to the horizon. This distance is to be held entirely as true as well as apparent, since parallax, even if some is present, cannot corrupt it, according to Axiom 3 [Axiom.3.] given above. Again, in the western quadrant the comet C and Capella D acknowledged the same vertical. Therefore the distance taken there is notably vitiated and made greater than it was in itself — namely by depressing the comet toward the horizon and moving the comet perpendicularly away from Capella; and so, as a consequence, this later distance is really the apparent one. When the one is taken from the other, therefore, the mean parallax results, which at other times we also like to call equal, or assumed.

[Margin: De parallaxi mediâ, æquali ſeu fictâ.] *On the mean, equal or assumed parallax.*

And here there is no need to attend to the proper motion; indeed, even if the comet has some motion, it does not hinder this matter at all, unless perhaps it is huge and extremely rapid. For since Capella, or the Bright Star of Aries, occupies a position exactly at a right angle with respect to the comet and its orbit, the proper motion adds very little, indeed almost nothing, to the distances D C or C E, or takes it away — even supposing that the comet moves upward or downward by its proper motion by a few minutes — provided that the distances between the comet and the fixed star are not very small or, what is the same thing, the fixed stars too close to the comet, but that they are removed from each other by at least 15°, 20° and more, as mostly happens in our observations and calculation.

But if the fixed stars — for example Capella or the Bright Star of Aries — not quite exactly at the right angle itself, but only approximately, to the comet and its orbit, are ob- served, where the comet's proper motion — perhaps quite conspicuous at that time, and swift — can harm the parallax not a little, it will be entirely necessary first to reduce and limit the distances by a particular method of calculation devised by me; but we have proposed to treat this separately later, to avoid greater confusion.

[Margin: Axiomata pro diſtinguendo motu viſo à vero; Fixâ ſub ipsâ,vel prope orbitam exiſtente.] *Axioms for distinguishing the apparent motion from the true, when the fixed star lies under the orbit itself or near it.*

From what we have recounted, I think that anyone not altogether unversed in astronomical matters has understood by what reasoning the parallaxes, above

all those of our phenomenon, are drawn out from the distances of the comet and the fixed stars, and what must be attended to most carefully in investigating them; although I have no doubt at all that almost everything can also serve for other phenomena, if it is applied with judgement. So that what has been said at length so far can be grasped the more easily, and also carried over with profit to the practice of calculation, here are some axioms for you, derived from what was said before and extremely necessary. Without them, indeed, even someone by far the most practised is scarcely able to take up this arduous and intricate business without faltering, let alone distinguish accurately at all times whether parallax attaches to the given observations and distances or not. The greater the labour with which we have constructed these axioms, the less you will need to grasp each point with their help — especially the points worth noting about the apparent and the true proper motion; and also by what method, and at what time, the distances between the comet and the fixed star are diminished and increased relative to each other, if there is any parallax. But this is only for the position, as we have already warned rather often, in which the fixed star is placed under the orbit itself or near it; the other situation, at a right angle, will be dealt with later.

Axioms of parallaxes, with respect to the true and apparent motion, when in the earlier, vertical observation the comet and the fixed star stand either under one and the same vertical or under different ones — the star, however, lying under the orbit or not very far from it — and in the later observation, parallel to the horizon, the comet and the fixed star are entirely equidistant from the zenith point [Axiomata parallaxium, ratione veri & viſi motus, Cometâ & Fixâ in priore obſervatione verticali, ſive ſub uno eodemq; verticali, ſive diverſis exiſtentibus; Stellâ tamen ſub orbitâ, vel non adeò procul ab eâ degente : in poſteriori verò horizonti parallelâ obſervatione à puncto Zenith, Cometâ & Fixâ omninò æquidiſtantibus.]

[Margin: Axioma primum.] *First axiom.*

1. When the comet, in the earlier, vertical observation, stands below the fixed star and in approach to it, whether under the same vertical or under different verticals — the star, however, lying not far from the orbit — and in the later, parallel observation the comet is removed from the horizon equally with the fixed star, or a little above the fixed star, the apparent motion is always greater than the true, if any parallax is present. And this comes out greater or smaller according to the smaller or greater altitude of the phenomenon,

[Margin: Axioma ſecundum.] *Second axiom.*

2. Given that the comet, in the first, vertical observation, is below or above the fixed star, but below the perpendicular drawn from the fixed star to the comet's vertical, and in recession from the fixed star — whether they are found under the same vertical or under different verticals — and that in the later, parallel observation the comet and the fixed star are equally distant from the horizon, or from the zenith point, then the

difference of the distances, or the apparent motion, is always smaller than the true, if some parallax lies hidden. But with the comet placed, in the earlier observation, above the fixed star and the perpendicular, likewise in recession, the apparent motion is greater than the true.

[Margin: Axioma tertium.] *Third axiom.*

3. When the comet, in the earlier, vertical observation, is under the same vertical circle as the fixed star, or under different ones, and is observed both above the fixed star and the perpendicular line and in approach; and again, in the later, parallel observation, the comet and the fixed star are removed from the horizon by an equal interval, the apparent motion is smaller than the true. But if they are found under different verticals, and the comet is then below the perpendicular line, even though it appears above the fixed star, the apparent motion is greater than the true, if any parallax attaches.

[Margin: Axioma quartum.] *Fourth axiom.*

4. But when the comet is in recession, and in the first, vertical observation is with the fixed star either under the same vertical or under different ones, yet above the fixed star and that perpendicular line so often mentioned; and in the second, parallel observation both are equally removed from the horizon — and no differently when the comet is a little lower than the star — the apparent motion, or the difference of the distances, is likewise greater than the true. But the contrary happens if the phenomena are found under different verticals and the comet below that perpendicular line, even though it seems to be above the fixed star; and if in turn, in the later, parallel observation, either the comet and the fixed star are entirely equidistant from the horizon or the comet stands a little lower, the apparent motion is smaller than the true, if any parallax is present.

[Margin: Axioma quintum.] *Fifth axiom.*

5. If the comet, under different verticals, is found in the earlier, vertical observation above the fixed star and in recession, even though it is also much higher than the perpendicular; and in the later, parallel observation the comet is higher than the fixed star and the perpendicular, the apparent motion is smaller than the true, if there is any parallax.

And so it stands with the apparent and the true motion when — which you should note very well — the earlier observed distance was vertical and the later one parallel to the horizon. But when the contrary occurs, namely that the earlier observed distance is parallel to the horizon and the later one vertical, everything that has been said is to be taken in the contrary way.

[Margin: Motum Cometæ proprium rectè traditum esſe.] *That the comet's proper motion has been correctly set out.*

But, you will say: I do not doubt that everything really stands so, just as it is also excellently founded in the truth of the matter, so that nothing whatever can be brought against it by anyone with reason — provided, that is, that you have the comet's proper motion known very accurately. But how is it to be

investigated, and from where may I be certain that it is entirely true? I answer: this true proper motion of the comet is to be taken, with due proportion made, from our later table of the proper motion, set out for the single days and hours of the comet's whole apparition and inserted in Book I, Section IX, page 110 [Libr.I. Sect.IX.pag.110]. That the proper motion has been set out most correctly in that table I forbear to demonstrate here at greater length, to spare time and paper, referring those in doubt to Sections IX and X of Book I. There we sought that motion very scrupulously and anxiously from a good many observations by means of lengthy calculation, and we handled the business as circumspectly as could ever be done, just as it would have had to be attempted for the other planets too, if their motion had not yet been explored. So I am entirely sure that no one can find anything wanting in this respect, unless someone wishes to bark against sound reason altogether and to deny our principles completely. Against such a person, indeed, I think there should be no disputing; he is to be left to his own opinion, to enjoy it alone.

[Margin: Non promiſcuè omnes obſervationes ad parallacticum negotium adhibendæ[[./:]]] *Not all observations indiscriminately are to be applied to the parallactic business.*

Finally, before we come to the calculation itself, I consider it of the utmost importance to warn in advance that not just any observations can be applied to this parallactic business, but only those acquired with singular diligence: those in which the distances were found to be neither too small nor large; in which the altitudes were neither too near the meridian, nor the azimuths too far removed from it, etc. The limits of time do not permit us to list them all. If these are supposed otherwise, misshapen and utterly monstrous triangles are supplied, so that scarcely anything accurate can be computed from triangles of that kind. And, to say it in three words, whoever strives to undertake this labour must not only be much practised in the astronomical dust, and well acquainted with all matters and capable in them; it is also necessary that he be endowed with excellent judgement, so that he is not unable to weigh each point duly and examine it exactly — above all, to separate the truer from the doubtful — and that he know best with what things, and with what kind of calculation, these or those observations agree, and also what should be done and what not. For not everything suits everyone, or every time, fittingly. For even if some thing is useful and excellent in itself and with respect to some definite matter, yet with respect to another matter it could be quite useless and very bad.

[Margin: Quasnam obſervationes Autor uſurpaverit.] *Which observations the author used.*

Hence it also happened that we were not permitted to compute parallaxes from just any observations, but only from those that served our purpose. Such were, above all, those made on the same day, or repeated within the space of twenty-four hours, and at the same time in the eastern and the western quadrant: namely, with the comet and the fixed star given under one and

the same vertical in the one observation, and with the distance parallel to the horizon in the other.

[Margin: Calculus parallaxium admodum operoſus.] *The calculation of parallaxes is very laborious.*

From whatever suitable observations there were, therefore, we went on to seek parallaxes, shirking none of the labours, however disagreeable and harsh, that had to be undertaken to track them down. Moreover, I was very rarely content to set up and carry through the investigation of any calculation by one single method; mostly I used very different ones, so that everything might be computed, examined and presented duly and correctly. And I believe — if the word may be pardoned — that we have omitted nothing that I ever judged would contribute even the least to that calculation, as all fairer critics of our works will candidly admit.

[Margin: Quare ex obſervatione diei 20 Decemb. parallaxis erui haud poſſit.] *Why the parallax cannot be derived from the observation of December 20.*

Let us now approach the calculation itself, since we have prepared for ourselves an easier access for undertaking it. I would indeed wish to begin from the first day of the apparition, namely December 20, and so to be able to derive the parallaxes in the order of all the following days. But since on that first day, the 20th, apart from that single observation drawn from the equilateral triangle, no other sufficient ones were granted, and nothing certain in this respect can be drawn from that single one alone, we must of necessity pass over that day and turn at once to December 23, on which the comet shone for us a second time. Indeed, on this day, the 23rd, we had no observations in which one distance of the comet and of a fixed star lying near the orbit was observed with the sextant under the same vertical, and the other, after some hours had passed, roughly parallel to the horizon. Hence it will be more laborious to undertake the calculations through distances, from the apparent longitudes and latitudes acquired through altitudes and azimuths and entered in the table in Book I, Section VIII, page 86 [Lib. I. Sect. VIII pag.86], which must first be sought out, than through bare distances observed with the sextant. However that may be, let us nonetheless undertake this work eagerly and fearlessly.

The earlier observation, which is to serve the first investigation, was obtained on the 23rd at $7^{h}\ 22^{m}\ 7^{s}$ in the evening, with the comet and the Heel of Perseus lying nearly under the same vertical; the later one at $10^{h}\ 57^{m}\ 20^{s}$ in the evening, with both phenomena equidistant from the horizon — nearly, I say. For this reason the parallax arising from these observations must first be reduced to the vertical, and then the prosthaphaeresis of inclination must likewise be applied to it, so that the genuine vertical parallax may come out. But because the Heel, although fairly near the orbit, was nevertheless not exactly under it, the two distances to be investigated will first have to be corrected and limited by a particular, suitable method first devised by us.

[Margin: Cur integer calculus in quibusvis ſupputationibus annexus fuerit.] *Why the whole calculation has been attached to each of the computations.*

So as not to be too lengthy, however, let us pass over the method of finding the distances, referring everyone to Book I, Section V [Sect. V. Libri Primi], and content ourselves only with the diagram itself and the whole calculation set beside it — which we have likewise resolved to do in all the following computations — so that everyone may the more readily survey the course of the whole calculation and weigh all the numbers rigorously.

Diagram. An engraved figure in a rectangular frame at the left of the measure. A horizontal straight line near the foot is the ecliptic; great-circle arcs descend from the point A at the top of the frame and cut the ecliptic at B, C and G; straight lines run from the star E down to the comet at L (with M) and at I. A straight line, the comet's orbit, runs from the upper right down to the left through F and H to the comet at I. Dotted lines run from E to D, to K and to F, and from E down to the ecliptic near H; a dotted arc joins M and L. Labels as read on the figure:

- A (top, apex of the arcs): A
- A (upper right, a second, larger italic letter standing apart from the lines): A
- D (left, on the outer arc): D
- K (left, below D): K
- Calcan. (above the star E): "Calcan." — the Heel
- E (right of the star): E
- F (on the orbit line, right): F
- Cometæ (along the orbit line, above F): "Cometæ" — of the comet
- Orbita (along the orbit line, below F): "Orbita" — orbit; with the label above, "Orbita Cometæ", the comet's orbit
- B (below the ecliptic, left): B
- C (below the ecliptic): C
- H (below the ecliptic, at the orbit): H
- G (below the ecliptic, right): G
- Ecliptica. (right end of the ecliptic): "Ecliptica." — ecliptic
- M (left of the comet at L): M
- L (right of the small circle): L
- Comet. (beside L): "Comet." — comet
- I (right of the small circle at the foot): I
- Comet. (beside I): "Comet." — comet
- Aut. ſculps. (lower right): "Aut. ſculps." — the author engraved it

No label on the figure was left unread. The text of this page names A, B, C, E, G, H, I and L; D, K, F and M stand on the figure and are not named in the text of this page.

[Margin: Elucidatio Schematis & analyſis Calculi.] *Explanation of the diagram and analysis of the calculation.*

In this figure, therefore, and also in all the others of this kind — let this be said once for always, both to save time and so that we do not sicken the reader with cabbage reheated so often — let G H B be the ecliptic, A its pole, I the

place of the comet at the earlier observation, and B its longitude, I B its latitude; L the place of the comet at the later observation, C its longitude, C L its latitude; E the Heel of Perseus, G its longitude, and E G its latitude. First, from the angle G A B — namely the difference of the longitudes of the Heel and of the comet at the earlier observation — and from the sides A I and A E, the latter being the complement of the latitude and the former made up of the latitude and 90°, the distance E I of the comet and the Heel at the earlier observation is sought, namely at $7^h\ 22^m\ 7^s$ in the evening. Then by the same method, from the angle G A C and the sides A E, the complement of the latitude of the Heel, and A L, the distance of the comet from the vertical point, let the distance E L itself of the later observation be found, at $10^h\ 57^m\ 20^s$ in the evening.

Investigation of Parallax I, for December 23, from two altitudes of the comet taken with the large azimuthal quadrant [Inveſtigatio Parallaxeos I. ad diem 23 Decembris ex duabus altitudinibus Cometæ,Quadrante magno Azimuthali captis.]

1st observation, hour	$7^h\ 22^m\ 7^s$ in the evening	Altitude of the comet	44° 28′ 0″	Azimuth, east	48° 19′
2nd observation, hour	$10^h\ 57^m\ 20^s$ in the evening	Altitude of the comet	50° 43′ 15″	Azimuth, west	31° 20′
Longitude of the comet at hour	$7^h\ 22^m\ 7^s$		28° 56′ 24″	Latitude of the comet	3° 0′ 21″ *A.*
Longitude of the Heel of Perseus			26° 17′ 12″	Quadrant of the circle	90° 0′ 0″
Angle EAD		Difference	2° 39′ 12″	Distance from the pole AI	93° 0′ 21″
				Latitude of the Heel	12° 8′ 0″
Logarithm of the complement of the latitude of the Heel, AE	2259			Complement to the quadrant	77° 52′ 0″ AF
Logarithm of the angle EAD	307277 *Add.*				
Logarithm of the perpendicular ED	309536		2° 35′ 38″	the perpendicular	
Antilogarithm AE	155975				
Antilog. of the perpendicular ED	102 *Subt.*				
Antilog. AD	155873		77° 51′ 14″ AD		
			93° 0′ 21″ AI		
Antilog. DI	3538		15° 9′ 7″ DI		
Antilog. of the perpendicular ED	102 *Add.*				
Antilog. EI	3640		15° 22′ 0″	Distance of the comet and the Heel	

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To find the distance of the comet from observation 2 [Pro inveniendâ diſtantiâ Comet. ex Obſerv. 2]

Longitude of the comet at hour	$10^h\ 57^m\ 20^s$		29° 1′ 41″ ♉	Latitude of the comet	1° 43′ 23″ south
Longitude of the Heel of Perseus			26° 17′ 12″ ♉	Quadrant of the circle	90° 0′ 0″
		Difference of the angle	2° 44′ 29″	Distance from the pole	91° 43′ 23″ AL
Logarithm of the complement of the latitude of the Heel, AE	2259			Antilog.	155975
Logarithm of the angle	304015 *Add.*				
Logarithm of the perpendicular EK	306274		2° 40′ 48″	Antilog.	110 *S.*
Antilog. AK	155865		77° 51′ 11″ AK		
			91° 43′ 23″ AL		
Antilog.	2959		13° 52′ 12″ KL		
Antilog. of the perpendicular EK	110 *A.*				
Antilog. of the distance EL	3069		14° 7′ 23″	of the comet and the Heel	
Earlier distance of the comet and the Heel			15° 22′ 0″		
Difference, or the apparent motion of the comet in the orbit			1° 14′ 37″		
But the true motion, from our table, for $3^h\ 35^m\ 13^s$ is found to be			1° 4′ 34″		
The difference of the apparent and the true motion gives the mean parallax			10 3		

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[Margin: Parallaxin ſubeſſe præſumitur.] *A parallax is presumed to be present.*

Once the two distances have been found in this way, let one be subtracted from the other, and the apparent motion of the comet results. Since this is

[245] the page sets this calculation as unruled lines, italic labels with roman figures and point-letters, with short rules under the figures of the fourth, eighth, eleventh, thirteenth and fifteenth lines. The table follows the page's order of groups along each line; its blank header row is not printed. Most degree, minute and second figures stand bare on the page; the marks are supplied here in the house form. The tags *A.* (after the latitude), *Add.* and *Subt.* are the page's own; *A.* is not expanded on the page. ♉ is the page's sign of Taurus.

[246] as above, with short rules under the figures of the second, fifth, sixth, eighth, tenth, twelfth and fourteenth lines; the lines from "Antilog. AK" to "Antilog. of the distance EL" stand indented toward the middle of the page. The tags *Add.*, *S.* and *A.* after the logarithms are the page's own and are not expanded on the page; "south" renders the page's *Auſtr.* The last line prints its two figures bare, "10 3", with no marks; they are left bare here. By the subtraction the page prints, the remainder of 1° 14′ 37″ less 1° 4′ 34″ is 10′ 3″.

greater than the true motion taken from our table in Book I, Section X, page 109 [Lib. I Sect. X pag.109] — the motion corresponding, that is, to the time elapsed between the two observations — and since at the same time the comet stands below the fixed star and is approaching it, it is presumed with certainty, according to our first axiom, that a parallax is indeed present in this calculation. Therefore, when the true motion is subtracted from the apparent, there results the fictitious or mean parallax for $7^{h}\ 22^{m}\ 7^{s}$ in the evening — that is, for the vertical observation made in the eastern quadrant, with the comet at an altitude of 44° 28′ — if, that is, the Heel of Perseus had lain exactly under the orbit itself.

But since the aforenamed Heel stood off from the comet's orbit itself by a whole degree and more, the difference of the distances, or the apparent motion of the comet, therefore came out somewhat smaller than if the Heel had appeared under the orbit itself. For this apparent motion is not taken along the same line as the true motion itself: the latter is considered in the orbit itself, whereas the former (namely when the fixed star declines from the orbit) is considered and estimated in a line inclined to the orbit, according to the distance of the fixed star.

[Margin: Id quod motu recto agitur,velocius eſt,quàm quod motu fertur obliquo.] *What is driven with a straight motion is swifter than what is carried with an oblique motion.*

But every body that is driven straight, or recedes from a terminus, is carried forward much more quickly, and approaches the terminus, than one that is drawn with an oblique motion along a transverse line, even if it is endowed with an entirely equal motion. From this it follows that the apparent motion of the comet — estimated, as it is in this position of the comet relative to the Heel, along a transverse or oblique line, namely that of the distance — is necessarily somewhat smaller than if it were taken to be considered in the orbit itself; and also that the straight motion is swifter than the oblique, as will shortly be demonstrated more clearly from the preceding figure.

In that figure, as you have gathered, I is the place of the comet at the earlier observation and L at the later; and so L I is the proper and true motion of the comet in the orbit, and I M the difference of the distances E I and E L, or the apparent motion. Now, therefore, when a perpendicular is let fall from M to L, the hypotenuse L I in that smaller triangle I M L, right-angled at M — namely the true proper motion in the orbit — is certainly greater than I M, the base of the triangle, by Theorem 33, Proposition 47 of Book I of Euclid [Theor. 33. prop. 47 Lib.I Euclid.]. Just so, L I also has a greater ratio to I F than L I has to I E, the hypotenuse, which is greater than the base I F. For the same magnitude has a greater ratio to a smaller magnitude than to a greater, by Theorem 8, Proposition 8 of Book V of Euclid [Theor. 8. Prop.8. V. Euclidis]. For example:

Let the base F I in the right-angled triangle I F E be 24, F E 10, and the hypotenuse E I 26, and L I 2. I say that 2 to 24, counted in the orbit, has a greater proportion than 2 to 26. For 2 to 24 is a 1/12 part of E F, of the

orbit, whereas 2 to 26, the line E I, the distance, is only a 1/13 part of that line. And who does not know that a 1/12 part is greater than a 1/13 part, so that no demonstration is needed?

[Margin: Quò Fixa ab orbitâ magis removetur, eò magis etiam verus à viſo loco differt.] *The farther the fixed star is removed from the orbit, the more the true place also differs from the apparent.*

It follows from this that the farther the fixed star stands from the orbit of the comet, the greater is the difference between the true proper motion L I and the apparent motion I M; that is, the more the fixed star is elongated from the orbit, the more the true motion exceeds the apparent. For the greater the distance E F of the star from the orbit, the greater also is the angle F I E, or L I M. And now, the greater E F is, or that angle which E F subtends, the greater too, certainly, is the hypotenuse E I relative to F I in the triangle E F I, or the hypotenuse L I relative to M I in the triangle L M I. And so, according to the same Theorem 8, Proposition 8 of Book V of Euclid cited above [8, Prop. 8, V Euclid.], the greater the hypotenuse, the smaller is the ratio of the apparent motion I M to the true motion L I.

[Margin: Quo in caſu differentia veri & viſi motus omnium ſit maxima.] *In which case the difference of the true and the apparent motion is the greatest of all.*

But the hypotenuse is greatest of all where the angle F I E, or L I M, is a right angle. Therefore in such a case the difference of the true and the apparent motion is the greatest of all. For there the apparent motion of the comet vanishes entirely, and the difference between the two distances of the comet and the fixed star becomes less than nothing — which was to be demonstrated.

[Margin: Quomodo motus viſus, diverſâ ab autore nunc primùm inventâ ratione limitandus ſit.] *How the apparent motion is to be limited by a different method now first devised by the author.*

Since, therefore, in this first example of parallax the Heel of Perseus is removed a little from the orbit — or, so to speak, has a latitude with respect to the orbit — and for this reason the apparent motion comes out smaller than it actually was, according to the clear demonstration above, reason absolutely demands that this motion be limited. Moreover, accomplishing this very fittingly, in a threefold, indeed a fourfold, way — one handed down by no one before, as far as I know, but devised by me — will be pos- sible. Before I begin to set out these ways, the order of the calculation demands that we first investigate the distance, or latitude, of the Heel from the orbit, E F. And this you will easily obtain by means of its longitude G and its latitude E G, to be taken from the table in Book I, Section III, page 19 [Lib.I, Sect.III. pag.19], and of the point of intersection of the orbit and the ecliptic, H, and likewise the true angle of the orbit and the ecliptic, G H F. These are always to be had from the small table in Section X of Book I, page 111 [Sect. X. Lib. I. pag.111], or more accurately still from the small table inserted in Section XI of the same Book, page 128 [Sect. XI. ejuſdem Lib. pag. 128], with due proportion, however, taken for the given time.

[Margin: Methodus Calculi.] *Method of the calculation.*

1. In the right-angled triangle E G H, let E H be sought from G H, the difference of the longitudes of the Heel and of the point of intersection of the orbit and the ecliptic, and from E G, the latitude of the Heel: that is, by adding their antilogarithms you will have the antilogarithm of the quantity sought.
2. In the same triangle let the angle G H E be sought likewise; you will find it from the logarithms, namely by subtracting the hypotenuse H E from the latitude E G.
3. From the angle G H E thus found, in this case (for sometimes it is also added), subtract the angle of the orbit and the ecliptic; the remainder will be the angle E H F.
4. In the right-angled triangle H F E, from the sum, taken as a logarithm, of the logarithms of the hypotenuse H E and of the angle E H F, there will come out the distance E F itself of the Heel from the orbit, corresponding to the given time. For this distance varies from day to day with the variation of the point of intersection and of the angle of the orbit and the ecliptic; hence that distance of the Heel can by no means serve for the observations of all the days of the comet's apparition, or for every calculation of parallaxes — which we wished to point out at the same time in this place.

Longitude of the Heel	56° 17′ 12″	AG		
Point of intersection of the orbit and the ecliptic	58° 32′ 30″	H	with due proportion taken	
Difference	2° 15′ 18″	Antilog.	77	
Latitude of the Heel, G E	12° 8′ 0″	Antilog.	2259 *Add.*	
Hypotenuse H E		Antil.	2336	12° 20′ 10″
Logarithm of H E, the hypotenuse	154343 *Subt.*			
Logarithm of E G	155975			
Log. of the angle G H E	1632	79° 40′ 36″		
Angle of the orbit and the ecliptic, A H F		73° 58′ 30″	corrected	
There remains the angle E H F		5° 42′ 6″	Logar.	230912 *Add.*
			Log. of H E, the hypotenuse	154343
Distance E F of the Heel from the comet's orbit, Log.			385255	1° 12′ 58″

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[Margin: Quadruplici modò diſtantiæ corrigi poſſunt.] *The distances can be corrected in four ways.*

With the distance of the Heel from the comet's orbit found in this way, let us turn to correcting the difference of the distances, or the apparent motion — or else to limiting the distances of the comet and the star. This can be done, as we have already indicated, in four ways, and it will be no trouble to set out and add them all for the benefit of curious philo-mathematicians.

[Margin: Prior modus.] *The first way.*

1. According to the first way, let both the angle F I E of the earlier observation and the angle F L E of the later observation be sought by subtracting the logarithm of the hypotenuse from the logarithm of the distance of the Heel from the orbit.

2 Since the comet, by advancing, has increased the angle F L E of the later observation (though only very slightly, so that without any loss this operation, even with a still greater given distance of the fixed star from the orbit, could have been neglected), let these two angles be added and the sum halved, so that the corrected angle may come out.

3 In this smaller triangle L I M, let the hypotenuse L I — namely the apparent motion corrected, or limited — be investigated from I M, the difference of the distances, or the apparent motion, and from the corrected angle just found: by adding cossically the mesologarithm of the side to the antilogarithm of the angle (that is, subtracting), so that the mesologarithm of the apparent motion sought results. From this let the true proper motion, found earlier from our table, be taken away; there remains the parallax of the orbit, for the same altitude of the comet, 44° 28′.

Logar. of the hypotenuse EI, distance of the Heel and the comet	15° 22′ 0″	132804	
		Subt.	
Logar. of the distance of the Heel from the comet's orbit, EF		385255	
Logar. of the angle FIE or LIM sought		252451	4° 35′ 39″
Logar. of the hypotenuse EL, distance of the Heel and the comet	14° 7′ 23″	141058	
		Subt.	
Logar. of the distance of the Heel from the comet's orbit, EF		385255	
Logar. of the angle FLE		244197	4° 59′ 25″
			Add.
		Sum	9° 35′ 4″
		Half	4° 47′ 32″

247 the page sets this calculation as unruled lines, italic labels with roman figures and point-letters, with short rules under the figures of the second, fourth, seventh, ninth and eleventh lines. The columns follow the page's alignment, and the blank header row is not printed. Most degree, minute and second figures stand bare on the page; the marks are supplied here in the house form. The tags *Add.* and *Subt.* are the page's own. A short slanting stroke stands before the figure 5 of the line "There remains the angle E H F"; it is not carried.

Mesolog. of the apparent motion	1° 14′ 37″	383006 +	
Antilog. of the corrected angle	4° 47′ 32″	350 — *S.*	
Mesolog. of the hypotenuse LI, or of the corrected apparent motion		382656	1° 14′ 53″
But the true motion from the table is found to be			1° 4′ 34″ *S.*
Therefore the parallax of the orbit for the 23rd, with the comet's altitude 44° 28′			10 19

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This parallax of the orbit, since the fixed star does not stand exactly under the orbit itself, exceeds the earlier mean parallax by 16″. And that the matter really is so has also been demonstrated at length above.

[Margin: Secunda ratio limitandi diſtantias.] *A second method of limiting the distances.*

But let us carry out this correction and limitation of the parallax by another route, by reducing both distances, I E and L E, to the orbit of the comet. That is, from I E, the distance of the earlier observation, and the angle I E F found above, let the base F I of the right-angled triangle I F E be found; and at the same time the side F L of the triangle L F E, from the distance L E of the later observation and the angle F L E, likewise known: by adding cossically, if need be, the antilogarithm of the angle to the logarithm of the hypotenuse, you will have the mesologarithm of the side sought. I F and L F, once found, give the distances reduced and corrected, and their difference gives the apparent motion reduced and corrected. From this take away the true proper motion given by the table, and there results, as before, the same parallax of the orbit.

Mesolog. of the distance of the star and the comet, EI	15° 22′ 0″	129164 +	
Antilog. of the angle FIE	4° 35′ 39″	322 — *Add.*	
Mesolog. of the distance reduced to the orbit		129486 IF	15° 19′ 11″
Mesolog. of the distance LE	14° 7′ 23″	137986 +	
Antilog. of the angle FLE	4° 59′ 25″	380 —	
Mesolog. of the distance reduced to the orbit		138366 LF	14° 4′ 18″
The difference gives the apparent motion reduced			1° 14′ 53″
But the true motion from the table			1° 4′ 34″
The remainder is the parallax of the orbit			10 19

[248] the page sets this calculation as unruled lines, italic labels with roman figures and point-letters, with short rules under the figures of the second, fifth, sixth, tenth and twelfth lines. The columns follow the page's alignment, and the blank header row is not printed. Most degree, minute and second figures stand bare on the page; the marks are supplied here in the house form, except in the last line, whose two figures "10 19" the page prints bare and which are left bare. The marks + and —, and the tags *Subt.*, *Add.* and *S.*, are the page's own; *S.* is not expanded on the page.

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[Margin: Quàm præciſè parallaxis orbitæ priori inventæ reſpondeat.] *How precisely the parallax of the orbit agrees with the one found before.*

You see, therefore, that although this inquiry was carried out with the help of a far smaller triangle, and also of both angles found, the parallax of the orbit itself is nonetheless entirely equal to the earlier one, so that not even a single second is lacking.

[Margin: Tertia ratio prioribus præferenda.] *A third method, to be preferred to the earlier ones.*

Yet I shall also disclose a third method of reducing parallaxes to the orbit, which I prefer to the earlier ones. For it is the easiest of all, and here you need no angle: immediately after the distance of the fixed star from the orbit has been found, the matter can be carried out simply from two sides, by solving a single right-angled triangle. I have also always used this method when the given fixed stars were not so very far distant from the orbit. 1 From the hypotenuse E I, the distance of the earlier observation, and the side E F, the distance of the fixed star from the orbit, find the side I F; then, from the hypotenuse E L, the distance of the comet and the fixed star in the later observation, find the side F L in the orbit, by simple subtraction: namely by taking the antilogarithm of F E, the distance from the orbit, away from the antilogarithm of the distances of the comet and the fixed star. Afterwards the difference of the sides found — or of the distances corrected, or reduced — shows the true parallax of the orbit itself.

Antilog. of the hypotenuse IE	15° 22′ 0″	3640.498	to a radius of 8 figures
Antil. of FE, the distance from the orbit	1° 12′ 58″	22.528 *S.*	
Antil. of the reduced distance FI		3617.970	15° 19′ 10″
Antilog. of the hypotenuse LE	14° 7′ 23″	3069.232	
Antil. of the distance from the orbit, FE	1° 12′ 58″	22.528 *S.*	
Antil. of the reduced distance LF		3046.704	14° 4′ 17″
Difference of the reduced distances, or the corrected apparent motion			1° 14′ 53″
The true proper motion is given by the table			1° 4′ 34″
The true and corrected parallax of the orbit			10 19

[249] as above, with short rules under the figures of the second and fifth lines and under the figures 14° 4′ 18″ and 1° 4′ 34″. The marks + and — and the tag *Add.* are the page's own. The last line prints its two figures "10 19" bare; they are left bare.

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[Margin: Juxta hanc quoq; Methodum eadem parallaxis orbitæ in ipſis ſecundis elicitur.] *By this method too the same parallax of the orbit is obtained, to the very seconds.*

It is clear, therefore, that by this way too, though entirely different and shorter, the parallax of the orbit can be found in exactly the same seconds. However, although this equation and limitation can hardly in any way be made more accurate by us, since, as you see, it agrees with the two preceding ones in the seconds themselves, I shall nevertheless add yet another method of equation, hitherto unknown.

[Margin: Quarta ratio, quando fixæ aliquantò longiùs ab orbitâ phænomeni diſtant, vel ſub angulo normali exiſtunt, admodùm conveniens.] *A fourth method, very convenient when the fixed stars stand somewhat farther from the orbit of the phenomenon, or lie at a right angle.*

I have found it very convenient not only in those cases — namely with fixed stars not very far removed from the orbit — but especially when the fixed stars whose distances were taken are either far removed from the orbit or view the comet and its orbit fully at a right angle. For this reason I have also always followed this procedure afterwards in similar examples.

The distances, moreover, are corrected in such a way, and the matter is brought to such a point, as if the phenomenon had lacked all proper motion; so that there is no need at all to take the true motion away from the difference of the distances — that is, from the apparent motion — or this from that, as has been done until now. Instead, simply by subtracting one corrected distance from the other, bare one, or vice versa, as the case requires, the true parallax of the orbit springs out at once.

[Margin: Analyſis Calculi.] *Analysis of the calculation.*

This operation, moreover, is likewise carried out with the help of the preceding diagram. 1. In the smaller right-angled triangle I M L, let the perpendicular L M be sought: namely from L I, the true proper motion between the two distances of the comet, given by the table, and from the angle F I E, or L I M, already found above. 2. In the same trian- gle, from L I and the perpendicular L M just found, let the side I M be sought. When this is afterwards taken away from E I, the distance of the comet and the fixed star in the earlier observation, it leaves E M in the other right-angled triangle, E M L. 3. And lastly, from the side E M just found and the perpendicular L M, let the distance E L be

[250] the page sets this calculation as unruled lines, italic labels with roman figures and point-letters, with short rules under the figures of the second and fifth lines and under the figures 14° 4′ 17″ and 1° 4′ 34″. The columns follow the page's alignment, and the blank header row is not printed. Most degree, minute and second figures stand bare on the page; the marks are supplied here in the house form, except in the last line, whose two figures "10 19" the page prints bare, the 10 under the minutes and the 19 under the seconds of the line above, and which are left bare. The tag *S.* is the page's own and is not expanded on the page.

computed, which is in reality the earlier distance E I reduced and equated — just as if the comet had had no proper motion. Therefore, when this limited distance is subtracted from the later, bare distance, there remains the parallax of the orbit itself that was sought. How the calculation is to be undertaken by logarithms, however, there is no call to say here, since the procedure of such a calculation already occurs many times in Book I. So the example itself follows.

Log. of the proper motion from the table	LI	1° 4′ 34″	397494	
Log. of the angle	FIE	4° 35′ 39″	252451 *A.*	
Logar. of the perpendicular	LM		649945	5′ 10″
Antilog. of the proper motion	LI	1° 4′ 34″	17.638	
Antilog. of the perpendicular	LM	5′ 10″	0.113	
Antilogar.	IM		17.525	1° 4′ 22″
Distance	EI			15° 22′ 0″
			Side EM	14° 17′ 38″
Antilogarithm	EM		3144.725	
Antilogarithm	LM		0.113 *A.*	
Antilog. of LE, or EI reduced and corrected			3144.838	14° 17′ 39″
But the later distance was found to be				14° 7′ 23″
Therefore the corrected parallax of the orbit				10 16

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[Margin: Calculorum ſumma convenientia.] *The calculations agree in the highest degree.*

It differs from the parallax found before by only 3″, which is of no consequence at all. I am indeed surprised that, although it was investigated in such diverse ways and at such length, it does not depart further from the earlier one. One therefore argues rightly that this parallax of the orbit, found in four ways for the comet's altitude of 44° 28′, is altogether most true.

[Margin: Parallaxis orbitæ & verticalis differentia.] *The difference between the parallax of the orbit and the vertical parallax.*

But note, as we have already touched on, that this parallax of the orbit is not wholly vertical, but mixed from the parallax of longitude and that of latitude; for that reason it came out somewhat smaller than it was in reality. For in the later distance, with the Heel, the comet was not entirely equally removed from the horizon, but appeared a little lower than the Heel. Therefore, if we weigh the matter carefully, the parallax pressed the comet down a little with

[251] the page sets this calculation as unruled lines, italic labels with roman figures and point-letters, with short rules under the figures of the second, fifth, seventh, tenth and twelfth lines. The columns follow the page's alignment, and the blank header row is not printed. Most degree, minute and second figures stand bare on the page; the marks are supplied here in the house form; the figures "5 10" of the fifth line stand under the minutes and seconds of the line above. The last line's two figures "10 16" the page prints bare, the 10 under the minutes and the 16 under the seconds of the line above, and they are left bare. The tag *A.* is the page's own and is not expanded on the page.

respect to the fixed star, since it then stood in a lower place, and made that distance somewhat greater than it was in itself. Strictly and accurately speaking, therefore, the parallax too ought deservedly to have been greater, however little. How far that small difference extended, however, and how great the genuine vertical parallax itself was altogether, the following calculation will show.

[Margin: De proſthaphæreſi & æquatione parallaxeos.] *On the prosthaphaeresis and equation of the parallax.*

Just as in the western quadrant, in the later, parallel observation, some prosthaphaeresis belongs to the parallax, so likewise in the eastern quadrant, in the vertical observation, a certain further equation is needed. For since in this earlier observation the comet and the Heel did not stand exactly under the same vertical, the parallax of the orbit that was found must by all means be reduced to the vertical; and in this way the said parallax will be made somewhat greater.

[Margin: Reductio ad verticalem parallaxin auget.] *Reduction to the vertical increases the parallax.*

For every reduction to the vertical always increases the parallax. In the western, parallel observation, however, from the prosthaphaeresis of inclination, not always is the parallax made greater, but sometimes also smaller, according to the position of the comet relative to the fixed star. In this first example, which we have in hand, the parallax likewise grows from the prosthaphaeresis of inclination, because the comet and the Heel are not entirely equally removed from the horizon. The chief reason is this. Since, as we have said, the later distance was made a little greater because of the comet's depression, that distance was certainly smaller in itself. Now when you subtract the smaller later distance from the greater eastern vertical distance (as always happens with comets approaching a fixed star), the apparent motion, or the difference of the distances, necessarily becomes greater than if the later distance were set somewhat larger. Given a greater apparent motion, therefore, the parallax too must be greater: for in this case the apparent motion is always greater than the true one when parallax is present — as is clearly seen from the globe and the diagram, if everything is rightly weighed.

[Margin: Non leviuſculus labor parallaxin ad verticalem redigere, & proſthaphæreſes inclinationis indagare.] *No slight labour, to reduce the parallax to the vertical and to track down the prosthaphaereses of inclination.*

Meanwhile, however, to reduce the parallax of the orbit to the vertical in the eastern quadrant, as well as to derive the prosthaphaereses of inclination in the western quadrant, so that the true and genuine vertical parallax itself, belonging to the given observation and altitude, may result, is not so easy a matter; it surely requires much labour and a fairly ample calculation. Above all, it proved the more laborious for us because it fell to us to pave the way in this field for the first time: for no one, as far as I know, has carried a torch before us in these finer matters. Let us therefore weigh the method of the calculation the more carefully, so that hereafter we may complete the remaining investigations the more readily and quickly.

[Margin: Hoc in exemplo nullâ reductione ad orbitam opus eſt.] *In this example no reduction to the orbit is needed.*

To begin with, then, in the eastern quadrant — namely in the first observation, made at $7^h\ 22^m\ 7^s$ — let the parallax found above, reduced to the orbit, 10′ 19″, be reduced to the vertical; although in this example there is no need at all for any reduction, since this reduction introduces no difference whatever, so that it can safely be omitted this time. But so that you need not take my word for it, we shall examine the matter itself, whether it is so or not; at the same time we shall show, with the following Diagram B and with rules, the way that must always be followed hereafter.

[Margin: Methodus inveniendi parallaxin orbitæ coæquatam, & ad verticalem reductam.] *Method of finding the parallax of the orbit equated and reduced to the vertical.*

Let L A M be the meridian, L M the horizon, P O the equator, Q N the ecliptic, R X the orbit of the comet, C the comet, A C K the circle passing through the comet, B C D the circle of declination, C D the comet's northern declination, K C the altitude of the comet, H the point of intersection of the comet's orbit and the equator, D H C the angle of the orbit and the equator, L K the azimuth, H C D the angle of the orbit and the declination, K C D that of the vertical and the declination, and H C K, or G C I, the angle of the orbit and the vertical, which we now need for carrying out this operation. But this angle cannot be found unless the angle of the orbit and the declination is first investigated from the right-angled triangle H C D, given, namely, the angle of the orbit and the equator for that time, 63° 2′ 0″, and C D, the northern declination of the comet itself: that is, by subtracting the antilogarithm of the side C D, the declination, from the antilogarithm of the angle, so as to have the logarithm of the angle sought, that of the orbit and the declination.

Then let the angle of the vertical and the declination at the comet, B C S, also be explored, from the azimuth K L, or its vertical angle S A B, and the side A B, the comple- ment, namely, of the elevation of the pole. This is done by first finding, in the right-angled triangle A S B, from the angle S A B and from A B, the side S B; and likewise, in the right-angled triangle C S B, from two sides — namely the hypotenuse C B, the complement of the declination, and the side S B just found — the angle sought, S C B, of the declination and the vertical: that is, by taking away the logarithm of the complement of the declination, C B, from the sum of the logarithms of the complement of the altitude and of the azimuth, you will have the logarithm of the angle sought, S C B, or of its vertical angle D C I. Afterwards, let the angle H C D be subtracted from this angle D C I so found, or be added to it, according to the given occasion and the situation of the circles, and the angle I C G sought, of the orbit and the vertical, will come out.

Finally, given the angle I C G and C G, the equated parallax of the orbit, in the right-angled triangle C G I, the hypotenuse C I, the parallax reduced to the vertical, is found from the mesologarithm, by subtracting the antilogarithm

of the angle from the mesologarithm of the side. And so the parallax is made somewhat greater if the angle of the orbit and the vertical is of some notable size; if not, it contributes little, or nothing at all, to the parallax — and we now have such an example at hand.

[Margin: Quid ſit parallaxi[?] orbitæ.] *What the parallax of the orbit is.*

For the parallax of the orbit found above is nothing other, in the attached Figure B, than the space that the same parallax subtends in the comet's orbit R C G H X — from the body of the comet, namely, towards the horizon — that is, C G; and this orbit of the comet, in this example of ours, nearly coincides with the vertical circle R C K drawn through the comet. Therefore the parallax reduced to the vertical, C I, though it is the hypotenuse of the triangle C G I, can become only very slightly greater, because the angle of the orbit and the vertical is too acute. When this angle is given larger, however, the ratio of the reduction of the parallax of the orbit, C G, to the vertical parallax, C I, also becomes more evident. Indeed, to put it in a word, this reduction of ours is nothing but a transfer of the parallax of the orbit, C G, to the vertical circle, C I: namely when, with the help of the angle I C G of the orbit and the vertical, once found, and of the side C G — that is, the assumed parallax of the orbit — the hypotenuse C I of the triangle I C G is explored.

[Margin: Parallaxis verticalis perpetuò major eſt parallaxi orbitæ.] *The vertical parallax is always greater than the parallax of the orbit.*

Since, therefore, C I, being the hypotenuse, is always greater than the side C G, the vertical parallax too is certainly always greater than the parallax of the orbit. In addition, as we pointed out above, every motion completed along an oblique line is always smaller than one carried out along a straight line; and the vertical R C K passing through the comet is the straightest of all with respect to the horizon, since it alone falls at a right angle, and consequently it is also straighter than the orbit itself.

[Margin: Niſi angulus orbitæ & verticalis conſpicuæ ſit magnitudinis,parallaxis orbitæ & verticalis vix quicquam differunt] *Unless the angle of the orbit and the vertical is of conspicuous size, the parallax of the orbit and the vertical parallax hardly differ at all.*

For that reason the parallax reduced to the vertical will also necessarily always be greater than the one completed in the orbit — provided that the angle is of some notable size; otherwise, as we have said, it introduces almost no difference into the parallax of the orbit.

1	Angle of the orbit and the equator	DHC	63° 2′ 0″	Antil. 79082	
	Declination	DC	17° 2′ 26″	Antil. 4490 *S.*	
	Angle of the orbit and the declination	HCD		Logar. 74592	28° 18′ 49″
2	Complement of the elevation of the pole	AB	35° 37′ 0″	Logar. 54067	
	Angle K A L of the azimuth, or	SAB	48° 19′ 0″	Logar. 29191 *Add.*	
			Sum	Log. 83258	

	Complement of the declination	CB	72° 57′ 34″	Log. 4490 *S.*	
	Of the angle of the vertical and the declination			Log. 78768	27° 3′ 29″ BCS or ICD 28° 18′ 49″ HCD or GCD

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3	Mesologarithm of the side	CG, or of the parallax	0° 10′ 19″	580880	
	Antilogarithm of the angle	ICG	1° 15′ 20″	24 *S.*	
	Mesologarithm of the parallax	CI		580856	10′ 19″ Parallax.

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Diagram. The left of two circle diagrams engraved side by side in one framed block, named by the large capital B below its centre. The horizon M L crosses the circle; a great circle runs from A through the comet C down to K, and another from R through C; an arc runs from B through C to D; the ecliptic and the equator cross the circle obliquely; the comet's orbit is drawn as an arc lettered along its length; dotted lines run from B and from A up to S, which stands outside the circle at the top.

- S (outside the circle, top): point
- R, A (upper rim): points
- B (upper left rim): point
- Q (upper right rim, script capital), P (right rim): points
- C (centre right, the comet, drawn as a small circle): point
- G, I, D, H (below C): points
- M (left rim), L (right rim): ends of the horizon
- K (below the horizon): point
- *Ecliptica*: Ecliptic
- *Horizon.*: Horizon
- *Æquator.*: Equator

[252] the page sets this calculation as unruled lines, italic labels with roman figures and point-letters, the step numbers 1 and 2 standing at the left, with short rules under the logarithms of the second, fifth and seventh lines. The columns follow the page's alignment, and the blank header row is not printed. Most degree, minute and second figures stand bare on the page; the marks are supplied here in the house form. The word "Sum" stands in the figure column on the page, left of "Log.". The tags *S.* and *Add.* are the page's own; *S.* is not expanded on the page. The calculation continues overleaf with a step numbered 3.

[253] these three lines complete the worked calculation of the previous page, as step 3, in the same unruled layout: italic labels, roman figures and point-letters, the step number at the left. A rule stands under "24 S."; the result 580856 stands below it. Line 2's degree, minute and second figures stand bare on the page; the marks are supplied here in the house form. The tag *S.* is the page's own and is not expanded on the page.

- *Orbita Cometæ* (set along the curve, inverted): Orbit of the comet
- *Oriens.*: East
- B (below the centre): the diagram's letter
- A small unlettered tick near the lower-left rim.

Diagram. The right of the two circle diagrams, named by the large capital C below its centre. The horizon M L crosses the circle; the comet's orbit runs from X through the comet C to G; great circles run from A through the star B to O and from A through C to K; an arc runs from Q through C; the equator and the ecliptic run obliquely down to T and N; dotted lines run from F to B and from C towards H and I. The engraver's signature stands at the lower right inside the frame.

- F, A (top rim): points
- Q (upper left rim, script capital), P (left rim): points
- B (upper centre, a star mark): point
- E, C (left of centre, C the comet): points
- H, I, D (right of and below C): points
- G (right rim, end of the orbit), X (left rim, start of the orbit): points
- R (below X): point
- M (left rim), L (right rim): ends of the horizon
- K, O (below the horizon): points
- T, N (lower right rim): points
- *Orbita Cometæ*: Orbit of the comet
- *Horizon.*: Horizon
- *Æquator.*: Equator
- *Ecliptica*: Ecliptic
- *Occidens.*: West
- C (below the centre): the diagram's letter
- *Autor ſculpſ.* (lower right of the frame): "The author engraved it."
- No letter S is drawn on this diagram.

You see, therefore, that since the angle of the orbit and the vertical, I C G, came out at only one degree and a few minutes, the parallax of the orbit has not been changed in the slightest by this reduction to the vertical, but has remained the same to the very seconds.

[Margin: Parallaxis verticalis reducta denuò limitanda eſt per proſthaphæreſin inclinationis.] *The parallax reduced to the vertical must be limited again by the prosthaphaeresis of inclination.*

Secondly, this same parallax, found and reduced to the vertical, must likewise be limited and equated in the western quadrant, because in this observation the distance of the comet and the Heel was not exactly parallel to the horizon; instead, the star was somewhat higher than the comet. Hence a certain prosthaphaeresis of inclination arises, and once it is found the whole business will be complete. But this latter inquiry is much more extensive, and it requires an entirely different diagram, one that represents the western configuration of

the comet — that is, of the later observation, at $10^h\ 57^m\ 20^s$ (such as the attached C).

[Margin: Quâ ratione proſthaphæreſis inclinationis eruatur.] *How the prosthaphaeresis of inclination is derived.*

In it, let L A M be the meridian, N Q the ecliptic, T P the equator, G X the orbit of the comet, A B O and A C K vertical circles, S the pole of the world, S B R the circle of declination, B the Heel of Perseus, C the comet, and B C the bare and uncorrected distance of the comet at the later observation. Let D C be a line parallel to the horizon, B D the difference in altitude of the comet and the Heel, C D B the parallactic triangle of the comet's inclination, B C D the angle of inclination, B I the first prosthaphaeresis, and B D the second and corrected prosthaphaeresis of inclination, which we have now set out to investigate for a true and genuine knowledge of the parallax.

[Margin: De proſthaphæreſi inclinationis primâ & ſecundâ.] *On the first and second prosthaphaeresis of inclination.*

For since, in this later observation, the fixed star and the comet did not stand entirely on a line parallel to the horizon, but the fixed star stood higher than the comet, the distance of the two bodies, C B, is not apparent and true at the same time, as it necessarily must be for establishing the true parallax — as was explained at length at the beginning of this Book, p. 170 and following. Next, having subtracted this pseudo-parallel distance B C of the later observation from the vertical distance of the earlier observation, a pseudo-motion also arises in the apparent motion; and so, moreover, when this adulterated apparent motion is compared with the true proper motion taken from the table, the genuine parallax is certainly vitiated in part — and indeed for a greater and a smaller angle of inclination D C B. Therefore it is necessary, as we also laid down at the beginning, that we examine this prosthaphaeresis of inclination, which always adulterates the true parallax, properly and as diligently as possible, so that afterwards, once this prosthaphaeresis is found, we may also correct completely the parallax previously reduced to the vertical, either by adding it or by subtracting from it.

[Margin: Methodus pro ſupputanda proſthaphæreſi inclinationis primâ.] *Method for computing the first prosthaphaeresis of inclination.*

Now let us say by what method the first prosthaphaeresis of inclination should be found. First, let the angle B A C be sought. Two data are indeed given us for finding it: namely the bare observed distance B C, and A C, the complement of the comet's altitude. But since in this oblique-angled triangle A B C two data alone do not suffice, a third must also be computed, namely A B, the complement of the altitude of the Heel at $10^h\ 57^m\ 20^s$ — so that at the same time you will not fail to know how much lower the comet is than the fixed star.

With all the sides of the oblique triangle B A C known, therefore, the angle B A C is sought in the usual way: let the difference of the two sides enclosing the sought angle be added to and subtracted from the third side; from the aggregate

of the logarithms belonging to the two sides just mentioned (those enclosing the sought angle), the half-remainder is the logarithm of the half-angle sought.

But if you also have the azimuth of the comet and of the fixed star known right from the start, this angle is derived by a much shorter way. For if the azimuths are given in one and the same quadrant, you will at once obtain the sought angle B A C itself from their simple difference; but if the azimuth of each is found in a different quadrant, the sum of the complements of each azimuth to 90° is the angle sought — or, what is the same, let the aggregate of the azimuths be subtracted from the semicircle, and the remainder is the angle sought, B A C.

2. In the same obtuse-angled triangle A B C, given the angle B A C just found, B A, the complement of the altitude of the fixed star, and also B C, the bare observed distance of the comet, let the angle B C A be investigated. By taking away the logarithm of the distance B C from the aggregate of the logarithms of the angle B A C and of the complement of the altitude of the Heel, A B (if, that is, the fixed star is higher than the comet; otherwise take the complement of the altitude of the comet), you will find the angle sought, B C A.
3. Let the angle D C A likewise be sought, in the triangle A D C, which is entirely acute-angled. We shall find it conveniently by dropping the perpendicular C H from the comet C onto the vertical of the fixed star, or, what is the same, the perpendicular D E from D onto the vertical of the comet. These two perpendiculars, C H and D E, are always entirely equal. For since D and the comet C are removed from the horizon by an equal space — or, what comes to the same, are equidistant from the vertical point A — the angles A D C and A C D must both be of exactly the same size. Since, therefore, A D and A C are similar sides, and each perpendicular is derived (as you will soon perceive) from the common angle D A C and an equal side, either A D or A C, certainly the perpendiculars must also be entirely equal — something it is not out of place to know properly here, since otherwise it is easy to stumble in the course of the calculation. Since, therefore, the said perpendiculars are of the same size as each other, seek just one of them, whichever you like, from the angle B A C and the complement of the comet's altitude (because the comet is lower than the fixed star; otherwise let the complement of the fixed star's altitude be used), by adding the logarithms. Likewise seek the side A E, in the right-angled triangle A E D, by subtracting the antilogarithm of the perpendicular D E just found from the antilogarithm of the complement of the comet's altitude, A C, or rather of A D, which is equal to it. Then, when the side A E is taken away from A C, E C will remain. Finally, in the right-angled triangle D E C, from E C and the perpendicular D E — namely the two sides that form the right angle — let the sought angle D C A be found, or C D A, which is wholly equal to the other. Then take away the angle B C A, found in step 2, from this

D C A, and you will have the angle of inclination D C B itself, which was to be sought this time.

[Margin: Mediante angulo inclinationis invenitur ultim⟦a/â⟧ æquatio parallaxeos.] *By means of the angle of inclination the final equation of the parallax is found.*

4. Once this angle is at last found, the way lies open to us to that final limitation, or equation, of the parallax, in this manner. Let the perpendicular B I be dropped, in that parallactic triangle B D C, from the fixed star B (because here it is the higher) onto the line D C parallel to the horizon; this serves us as the prosthaphaeresis of inclination — namely, by how much the vertical parallax found above should have been greater on account of this inclined distance B C. For the comet, while it was by no means equidistant from the horizon with the star, but much below the fixed star, certainly makes this distance somewhat greater, with respect to the parallax that depresses the comet, than it really was in this later observation. And since, with the comet engaged in approaching the fixed star, as you have perceived, the later distance is always smaller than the earlier, and since, when the one is subtracted from the other, it is certain that the mean parallax results: therefore, if the later distance is greater than it ought to be, the parallax will come out smaller than if the later distance were smaller. This is what also happened in this case, if you perceive the matter rightly; and so, consequently, the prosthaphaeresis B I that is to be sought will have to be added to the previous parallax reduced to the vertical.

[Margin: Proſthaphæreſis hâc vice adjectiva eſt.] *This time the prosthaphaeresis is additive.*

This prosthaphaeresis of inclination B I is easily found from the logarithm in the following way: take the parallax reduced to the vertical above in place of B C, in that parallactic triangle B D C, and then use the angle of inclination D C B derived in step 3, adding the logarithm of each. Finally, once the prosthaphaeresis B I is found, let it be added this time to the parallax reduced to the vertical, and the genuine parallax, first equated, will come out. First equated, I say: for if we consider the matter still more deeply, this prosthaphaeresis B I is not in every respect the true and genuine one belonging to this observation; B D is. For the comet has been depressed by parallax in the vertical circle, and the distance B C has been corrupted not along the perpendicular line B I but along the vertical B D. For this reason B D too must be sought and added to the same parallax reduced to the vertical, so that the genuine vertical parallax itself, equated a second time, may be derived. But by what way this later, second prosthaphaeresis B D ought to be investigated will be told afterwards, once we have first said something about the axioms of prosthaphaereses that are supremely necessary for this business.

[Margin: Parallaxis primò coæquata.] *The parallax first equated.*

[Margin: An proſthaphæreſis addenda, an verò ſubtrahenda ſit ? haud cuivis tam promptè percipi datur.] *Whether the prosthaphaeresis is to be added or rather subtracted is not something just anyone can perceive so readily.*

You will have understood, however, I think, from what has been said here and there, that the parallax reduced to the vertical, on account of the comet's so varied situation with respect to the fixed star in this later observation, when the distance is not given entirely parallel to the horizon, is vitiated in different ways, being made now greater, now smaller; and hence the prosthaphaeresis of inclination, by which that parallax is remedied, is now to be added, now to be subtracted. But as to when it is of this or that character — truly, I frankly confess, the matter calls for a deeper inquiry and is very difficult to perceive, so that it is not granted to just anyone here to go to Corinth, but only to one most skilled in the celestial mysteries, who examines and weighs the whole matter with the utmost powers of his mind; for the rest, it is nearly impossible to attain these things without a Delian diver (as the proverb usually says). So, for their sake, let us present certain axioms, directed for the most part to our comet and put together by me with no small labour, from which it will at once be clear, without any error or tedium, whether the prosthaphaeresis — the first as well as the second (for they are always of the same quality) — is additive or rather subtractive, in any given position whatever of the comet and the fixed star. From this, certainly, no little help will flow to all who are occupied in this business of parallaxes; but if these axioms are not known, the matter turns out quite obscure and is scarcely perceived, and by rather few.

[Margin: Autor certa axiomata conſtruxit,quorum beneficio cuilibet illicò cognoſcere datur, cujus affectionis ſit proſthaphæreſis tam prima quàm ſecunda in[?]linationis.] *The author has constructed certain axioms, by means of which anyone may at once know of what character the prosthaphaeresis of inclination [?] is, the first as well as the second.*

[Margin: Axiomata ſequentia,quibus caſibus conveniant.] *The following axioms: to which cases they apply.*

[Margin: Quando proſthaphæreſes contrariæ fiant denominationis.] *When the prosthaphaereses become of contrary denomination.*

[Margin: Quando fixæ ad Cometam ſub angulo recto exiſtunt, aliis diverſis planè axiomatibus opus eſt.] *When the fixed stars stand at a right angle to the comet, other, entirely different axioms are needed.*

The following axioms, however, are constructed for those cases in which the fixed stars lie either beneath the comet's orbit itself or very near it; and in addition — mark this well — when the distance at the earlier observation is found under practically one and the same vertical, while the distance at the later observation is found roughly parallel to the horizon. But if the contrary has occurred — namely, when the distance of the earlier observation is found parallel and that of the later one vertical — each prosthaphaeresis of inclination will have to be applied, according to the axioms set out below, in the contrary way: that is, the additive becomes subtractive, and vice versa — that is, where

the fixed stars lie beneath the comet's orbit itself, or near it. Where, however, the fixed stars are found at roughly a right angle to the comet and its orbit, the case with this prosthaphaeresis of inclination is truly very different, and special axioms are needed. But we shall speak about these at length in connection with Investigation IX, when an example of that kind will be put forward, in which the fixed star viewed the comet at a right angle.

Axioms of Parallaxes with Respect to Addition and Subtraction: namely, when the fixed stars lie beneath the orbit itself or near it, that is, at a very acute angle to the comet; and moreover, with the distance roughly vertical in the earlier observation, and the distance roughly parallel to the horizon in the later observation [Axiomata Parallaxium ratione additionis, & ſubtractionis : quando nimirùm Stellæ Fixæ ſub ipsâ orbitâ, vel propè eam reſident, ſub angulo ſcilicet admodùm acuto ad Cometam : adhæc in priori obſervatione, datâ diſtantiâ circiter verticali, & in poſteriori obſervatione diſtantiâ circiter horizonti parallelâ.]

[Margin: Axioma primum.] *The first axiom.*

1 When the comet in the east, or in the first, vertical observation, is lower than the fixed star and approaching it; and likewise, in the west, or in the later, parallel observation, the comet is lower in altitude both than the fixed star and than the perpendicular line falling from the fixed star onto the comet's vertical, the prosthaphaeresis of inclination is additive. Conversely, when in the west, or in the second, parallel observation, the comet is higher than the fixed star, and the line per- pendicular, the prosthaphaeresis is subtractive; but if the comet is lower than that perpendicular line, although it appears higher than the fixed star, the prosthaphaeresis is additive.

[Margin: Axioma ſecundum.] *The second axiom.*

2. When the comet in the east, or in the earlier, vertical observation, is higher than the fixed star and the perpendicular line, and is approaching it; and conversely, in the western region, or in the later, parallel observation, the comet is lower than the fixed star in altitude, then the prosthaphaeresis of inclination is to be subtracted. But it is to be added when the comet in this western region, namely in the parallel observation, is higher than the fixed star and the perpendicular line. But if the comet is lower than the perpendicular line, although it appears higher, the prosthaphaeresis is subtractive. And if in the east, in the roughly vertical observation, it is below the perpendicular, although higher than the star, and in the west lower, the prosthaphaeresis is additive.

[Margin: Axioma tertium.] *The third axiom.*

3. When the comet in the east, namely in the earlier, vertical observation, is lower than the fixed star and receding from it; and then in the west, namely in the second observation, the comet is lower than the fixed star in altitude, the prosthaphaeresis of inclination is additive. It is subtractive, however, if in the west, namely in the second observation, the comet is higher than the fixed star and the perpendicular line; but if in the

west, namely in the second observation, the comet is lower than the perpendicular line, although higher than the star, the prosthaphaeresis is additive.

[Margin: Axioma quartum.] *The fourth axiom.*

4. When the comet in the east, in the earlier, vertical observation, under one and the same vertical circle, is higher than the fixed star and the perpendicular line falling from the fixed star onto the comet's vertical, and is approaching it; and conversely, in the west, in the later, parallel observation, the comet is lower than the fixed star in altitude, the prosthaphaeresis of inclination is subtractive. But in the west, in the later observation, when it is higher than the fixed star and the perpendicular line, the prosthaphaeresis is additive. But if in the east, namely in the earlier, vertical observation, it is lower than the perpendicular line, although the star stands higher, while in the west, in the later, parallel observation, it is above the fixed star and the perpendicular, the prosthaphaeresis is subtractive.

[Margin: Axioma quintum.] *The fifth axiom.*

5. When the comet in the east, in the earlier, vertical observation, is higher than the fixed star and the perpendicular and is receding, but with each phenomenon standing under different verticals; and conversely, in the west, in the later, parallel observation, it is above the fixed star and the perpendicular, the prosthaphaeresis is subtractive. But in the later observation, with the comet below the fixed star, the prosthaphaeresis is additive; but if it is above the perpendicular, although the comet appears below the fixed star, the prosthaphaeresis is subtractive.

When, however, the contrary occurs, it must then be noted that, where the first observation, or distance, was vertical in the west, and the later one, in the eastern region, was taken as parallel, the prosthaphaeresis of inclination, as we have already mentioned above, takes on the contrary effect with respect to addition and subtraction.

More cases, and other ones, could indeed still be given for some other comets; but since this business would be too lengthy, and I would overwhelm the reader too much, I deliberately do not wish to extend these axioms further. Nor, truly, is it much to the purpose: for from those just put forward I hope that the characters of the prosthaphaereses for each and every case will easily be understood by philo-mathematicians who weigh the matter duly and accurately. But so that at a single glance

[Margin: Hæc axiomata quanquam non ſunt omninò univerſalia,poſſunt tamen ad quoscunq; caſus ab attento harum rerum ſtudioſo facilè extendi.] *Although these axioms are not entirely universal, they can nevertheless easily be extended to any cases whatever by an attentive student of these matters.*

everything contained in the preceding axioms may be evident, I have constructed a small table, by means of which, in all these cases — once it is known, that is, in which region of the sky each distance was observed; then the comet's

place with respect to recession and approach; likewise with respect to the perpendicular and the fixed star, namely whether the phenomenon stands above or below it — you will recognize without labour of what character the prosthaphaeresis is, to be added or to be subtracted.

	Below the fixed star, approaching.	Above the fixed star and the perpendicular, approaching.	Above the fixed star but below the perpendicular, approaching.	Below the fixed star, receding.	Above the fixed star and the perpendicular, receding.	Above the fixed star but below the perpendicular, receding.	Above the fixed star and the perpendicular, receding.
Below the fixed star and the perpendicular.	The prosthaph. is additive.	Subtractive	Additive.	Additive.	Subtractive	Subtractive	Additive.
Above the fixed star and the perpendicular.	Subtractive	Additive.		Subtractive	Additive	Subtractive	Subtractive
Below the fixed star and above the perpendicular.							Subtractive.
Above the fixed star but below the perpendicular.	Additive	Subtractive	Additive.	Additive	Subtractive		

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With these axioms thus handed down, let us proceed with our calculation, namely by inquiring into the prosthaphaeresis of inclination B I itself. Therefore let the altitude of the Heel at the later observation first be computed.

1. To find the altitude of the Heel. For the 23rd day, at $10^{h}\ 57^{m}\ 20^{s}$.

254 the table is ruled. A head in roman, "Cometâ in priori obſervatione verticali exiſtente." (With the comet in the earlier, vertical observation), spans the first six value columns; a boxed head, "Cometâ v. & Fixâ in priori obſerv. ſub diverſis verticalibus exiſtentibus." (With the comet *v.* and the fixed star standing under different verticals in the earlier observation), stands over the seventh column alone. A label set vertically beside the row heads, "Cometâ in poſteriori parallelâ obſervatione exiſtente." (With the comet in the later, parallel observation), spans the four rows. The column heads describe the comet in the earlier observation, the row heads the comet in the later observation. Empty cells are empty on the page.

Right ascension of the Sun			273° 8′ 57″			
Elongation from the meridian			164° 20′ 0″			
			437° 28′ 57″			
Right ascension of the Heel			50° 39′ 37″			
			386° 49′ 20″			
Excess over 360, distance from the meridian			26° 49′ 20″	Logarithm	79578	
Declination of the Heel			31° 7′ 38″	Antilogarithm	15546 *A.*	
	BF			Logarithm	95124	22° 43′ 19″
Logarithm of the declination	BR	65983				
Antilogarithm of the perpendicular	BF	8079 *S.*				
Antilogarithm	SF	57904	55° 54′ 51″			
Complement of the elevation of the pole	S A		35° 37′ 0″ *S.*			
	AF		20° 17′ 51″	Antilogarithm	6411	
	BF			Antilogarithm	8079 *A.*	
Antilogarithm of A B, or logarithm of	B O				14490	59° 53′ 40″ Altitude of the Heel.
				Altitude of the comet		50° 43′ 15″
				Difference, or angle DBC		9° 10′ 25″

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Since, then, the altitude of the Heel is given as 9 degrees greater than the comet's, the distance B C is in no way parallel to the horizon; rather, it forms the angle of inclination D C B, which let us now explore by calculation.

2. To compute the angle B A C.

B C, distance of the comet and the Heel, uncorrected	14° 7′ 23″	Given from the calculation above, p. 183				
Altitude of the comet at $10^h\ 57^m\ 20^s$	50° 43′ 15″	Its complement	C A	39° 16′ 45″	Log.	45712
Altitude of the Heel, B O	59° 53′ 40″	Its complement	B A	30° 6′ 20″	Log.	68997 *A*

[255] the calculation is set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed over the first figure row and over the rows giving 22° 43′ 19″, 55° 54′ 51″ and 59° 53′ 40″; the other rows stand bare on the page, and the marks are supplied here in the house form. The tags *A.* and *S.* are the page's own and are not expanded on the page. The figures 360 in the label of the sixth row are printed bare.

	Difference	9° 10′ 25″	Sum	114709	
Complement of the altitude, star and comet	9° 10′ 25″				
Distance of the Heel and the comet, B C	14° 7′ 23″				
Sum	23° 17′ 48″				
Half	11° 38′ 54″		Log-a-rithm	159984	
Difference	4° 56′ 58″				
Half	2° 58′ 29″ [?]		Log-a-rithm	314253	
Later aggregate				474237	
Earlier aggregate				114709	
Difference				359528	
Half				179764	9° 32′ 14″
			Dou-bled		19° 4′ 28″ Angle sought, B A C.

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3. To compute the angle of inclination D C B.

Angle B A C	19° 4′ 28″	Log.	111842		
Complement of the altitude of the Heel	30° 6′ 20″	Log.	68997 *A.*		
		Log	180839		
Side 3 B C	14° 7′ 23″	Log.	141057 *S.*		
Angle sought, B C A		Log.	39782	B C A	42° 12′ 18″
Angle B A C	19° 4′ 28″	Log.	111842		
Complement of the altitude of the comet	39° 16′ 45″	Log.	45712 *A.*		
Perpendicular D E			157554	D E	11° 56′ 26″
Complement of the altitude of the comet	39° 16′ 45″	Antil.	25573		
Perpendicular D E	11° 56′ 26″	Antil.	2188 *S.*		
		Antil.	23385	A E	37° 40′ 32″ Sub-tract.
		Complement of the altitude of the comet		A C	39° 16′ 45″

256 the calculation is set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over the first figure rows; the other rows stand bare on the page, and the marks are supplied here in the house form. The tag *A* is the page's own.

	Difference			E C	1° 36′ 13″
Side E C	1° 36′ 13″	Log.	357610 +	Subtract cossically.	
Perpendicular D E	11° 56′ 26″	Mesol.	155366 +		
Angle D C A		Mesol.	202244 —	D C A	82° 27′ 18″
Let the angle B C A found above be subtracted					42° 12′ 18″
The remainder is the angle of inclination D C B					40° 15′ 0″

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4. For the first prosthaphaeresis of inclination.

Parallax reduced to the vertical	0° 10′ 19″	Log-a-rithm	580856		
Angle of inclination D C B	40° 15′ 0″	Log-a-rithm	43676 *A.*		
Prosthaphaeresis of inclination B I, first, or equal			624532	6′ 40″	
The parallax reduced to the vertical was				10′ 19″	Add.
Therefore the vertical parallax, first equated, becomes				16′ 59″	for the altitude of the comet, 44° 28′, namely at 7^{h} 22^{m} 7^{s} in the evening, on December 23.

Since, however, this prosthaphaeresis B I that has been found is not yet the true and genuine one, but B D is, as you have perceived, this one too must therefore now be sought.

[Margin: Methodus calculi pro parallaxi verâ ſecundò coæquatâ verticali.]
Method of calculation for the true vertical parallax, equated a second time.

But usually so very small a difference is observed between B I and B D that it hardly repays the labour of the calculation, especially when B I is only of one minute or another. Lest we should be the more negligent in this part of the calculation on that account, however, let us append both the method of the calculation itself and the calculation itself. 1. In diagram C above, then, let the angle D B C be sought in the right-angled triangle C H B, by means of the perpendicular C H found above, which is entirely equal to D E, and of B C, the

[257]set unruled, as the step above. The signs + and — after three of the logarithms are the page's own. The figure 3 in the label "Side 3 B C" is printed so and is not explained on the page.

distance of the comet and the fixed star: that is, by subtracting the logarithm of this one from the logarithm of the other, the logarithm of the angle H B C, or D B C, will come out. 2. Let the true B I be investigated from the distance B C and the angle of inclination D C B, by adding their logarithms. 3. The angle C B I, in the right-angled triangle C I B: subtracting the mesologarithm of C B (cossically, if need be) from the mesologarithm of the perpendicular B I, the remainder is the antilogarithm of the angle C B I; and this, always subtracted from the angle D B C found in step 1, produces the angle I B C. 4. In that smaller, acute-angled triangle B I C, let B D, the second prosthaphaeresis, finally be sought in this way: from B I, namely the first prosthaphaeresis, and the angle I B C just found, by subtracting the antilogarithm of the angle from the mesologarithm of the side B I, the first prosthaphaeresis, there will remain the mesologarithm sought, that of B D, the second prosthaphaeresis of inclination. Afterwards, according to the situation of the comet with respect to the fixed star, let this prosthaphaeresis be added to, or subtracted from, the parallax reduced to the vertical, derived on p. 191, following the axioms above; and you will obtain the true vertical parallax, equated a second time, for a certain given altitude of the comet.

[Margin: In inquiſitione proſthaphæreſeos poſterioris tutò ſcrupula ſecunda omitti posſunt.] *In the inquiry into the later prosthaphaeresis the seconds can safely be omitted.*

Here it should be noted that in this inquiry into the later prosthaphaeresis there is no need to use seconds, but only minutes, since the matter comes to the same thing; nor does it add anything in the seconds to the second prosthaphaeresis, or take anything away, as will be clearly evident to anyone who examines the following calculation, even though the prosthaphaeresis there amounts to nearly 7 minutes. This time, however, let us extend the calculation to seconds, but in future let us spare ourselves that labour.

1.	Logarithm of the hypotenuse C B, distance of the comet and the Heel	14° 7′ 23″	Logar.	141057 *S.*	
	Perpendicular C H, which equals D E	11° 56′ 26″	Logar.	157554	
	Angle H B C, or D B C		Logar.	16497	57° 59′ 10″ D B C
2.	Hypotenuse C B, distance of the comet and the Heel	14° 7′ 23″	Logar.	141057	
	Angle of inclination D B C	40° 15′ 0″	Logar.	43676 *A.*	
	Perpendicular B I		Logar.	184733	9° 4′ 16″ B I
3.	Hypotenuse C B, distance of the comet and the Heel	14° 7′ 23″	Mesol.	137986 +	Subtract cossically.
	Perpendicular B I	9° 4′ 16″	Mesol.	183473 +	

		An-gle	Antilog.	45487 +	50° 36′ 53″ *C B I*
			Angle found above		57° 59′ 10″ D B C
			Differ-ence, or angle I B D		7° 22′ 17″
4.	Prosthaphaeresis of inclination, equal	6′ 40″	Mesol.	624532	
	Angle I B D just found	7° 22′ 17″	Antil.	830 *S.*	
	Prosthaphaeresis of inclination, equated a second time		Mesol.	623702	6′ 43″ *A.* According to axiom 1.
	The parallax reduced to the vertical, however, was				10′ 19″
	Therefore the true vertical parallax, equated a second time, is				17′ 2″ For the altitude of the comet, 44° 28′, observed at 7^{h} 22^{m} 7^{s} on December 23.

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[Margin: Novâ ratione differentiam parallaxium eruere.] *To derive the difference of the parallaxes by a new method.*

Finally, with this genuine vertical parallax, equated a second time, found in this way, we shall now also show, likewise by a new method, how the difference between the parallaxes of two given altitudes of the comet can be derived: provided that the angle D C B (when the comet is above the fixed star), or the angle A C B (when the comet is below the fixed star, as in this example of ours), which the line of distance and the vertical of the comet form, does not exceed 30, or at most 40 degrees. If it is much greater, you will by no means be able to determine the parallax so precisely at each altitude, especially if there is some notable parallax.

First, then, just as in the earlier, eastern observation we reduced the parallax of the orbit to the vertical, so in this later, western observation too let that same parallax of the orbit, 10′ 19″, be reduced to the vertical by the same method: subtract the antilogarithm of the angle A C B, found in step 3 of the first prosthaphaeresis, from the mesologarithm of the parallax of the orbit, and you will have the mesologarithm + of the parallax reduced to the vertical, for the

[258] the calculation is set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over the first figure rows; the other rows stand bare on the page, and the marks are supplied here in the house form. The signs + and the tags *A.* and *S.* are the page's own. The label of the fifth row prints the angle of inclination as "D B C", where the prose above names it "D C B"; kept as printed. "According to axiom 1." is set on two lines joined by a printed bracket.

altitude of the comet in the later observation. Take this away from the parallax reduced to the vertical for the earlier altitude, found on p. 186, and there will remain the difference of the parallaxes itself, applicable to both altitudes. This difference, in turn, subtract from the genuine parallax equated a second time that has been found, when the comet is higher at the later altitude than in the earlier observation; but if the comet's altitude in the later observation is lower, add it to the parallax just mentioned. In this way you will establish the true and genuine vertical parallax, equated a second time, for the later altitude of the comet.

[Margin: Præſtat ad certam altitudinem parallaxin, quàm ejus differentiam elicere.] *It is better to derive the parallax for a certain altitude than its difference.*

Meanwhile, however, I advise that, whenever it can be done, you examine the parallax for one certain altitude with the aid of the prosthaphaereses (a method I prefer to this one); but where the observations do not permit this at all, you may use this difference of parallax, and you will proceed safely, unless the said angle A C B, as I have already warned, grows too large. In our example set out here, although that angle turned out to be still a little greater than 40 degrees, it nonetheless gives the genuine vertical parallax for the earlier altitude of the comet almost the same as from the prosthaphaereses, and scarcely two seconds smaller. Let this serve you as a test; and it is proof that the difference of parallax has been derived by our method correctly and properly.

Parallax of the orbit	0° 10′ 19″	Mesolog.	80880		
			+		
A C B, of the angle	42° 12′ 18″	Antilog.	30009		
			+ *S.*		
Parallax reduced to the vertical		Mesolog.	50871	13′ 56″	of the later observation
			+		
The parallax reduced to the vertical, of the earlier observation, was				10′ 19″	
Therefore the difference of the parallaxes between the altitudes 44° 28′ and 50° 53′				3′ 37″	Subtract, because the comet is higher in the later observation.
True vertical parallax, equated a second time, for the altitude 44° 28′				17′ 2″	
Therefore the parallax for the later observation, at the comet's altitude 50° 43′ 15″				13′ 25″	

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[259] the calculation is set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are subtracted. The degree, minute and second marks are printed only over some rows; the other rows stand bare on the page, and the marks are supplied here in the house form. The signs + and the tag *S.* are the page's own. "In the later observation" is printed on the following line, as a turn-over of "Subtract, because the comet is higher".

[Margin: In majorem rei fidem ex diverſis inſuper aliis obſervationibus ſimili methodo parallaxis pro die 23. Dec. ſupputetur.] *To make the matter more credible, let the parallax for December 23 be computed by a similar method from further, different observations as well.*

But so that we may be all the more secure, we do not wish to rest content with this single calculation, set out for this 23rd of December; rather, let us add four more calculations, from entirely different observations made at different times, examining in this second, following inquiry the parallax now from entirely other distances, namely those of the comet and the bright star of Medusa; retaining, however, the earlier observation, at $7^h\ 22^m\ 7^s$, since in the eastern quadrant, at about that time, no other observation was made in which the comet stood together with Algol under one and the same vertical. In place of the later observation of the earlier calculation, however, let us take the one made at $11^h\ 28^m\ 0^s$, in which the said distance was found still more convenient, as being more nearly parallel to the horizon, than the later distance of the comet and the Heel of Perseus in the preceding calculation. From this inquiry, therefore, we hope for a parallax that is almost more accurate still, especially because the fixed star, namely the bright star of Medusa, stood almost beneath the orbit itself, removed from it by scarcely a few minutes.

Diagram. Diagram D, engraved and set in the text at the left. From an apex A at the top two arcs and a straight line descend to a horizontal line, the ecliptic, on which B, C, H and G stand from left to right. A straight line, the orbit, crosses from the upper right. D, F and E stand on one level, joined by dotted lines, E marked with a small star; a line, the comet's, runs from E down to the left. Below the ecliptic two points marked with small circles are lettered L and I. A large capital D, the figure's own letter, stands to the right of L, and the engraver's signature stands at the lower right.

- A (apex, top): A
- Orbita (along the straight line from the upper right): "Orbit"
- D (left, on the level of F and E): D
- F (middle, on the same level): F
- E (right, with a small star): E
- Cometa (along the line from E): "Comet"
- Ecliptica (right end of the horizontal line): "Ecliptic"
- B, C, H, G (under the horizontal line, left to right): B, C, H, G
- L (below the ecliptic, with a small circle): L
- D (large capital, right of L): the figure's letter D
- I (lowest point, with a small circle): I
- Aut ſculps. (lower right, script): the engraver's signature, as printed

For the rest, since the distances of the comet and Algol, on which we must now rely, are not yet known to us from observation, they must first be derived by calculation, as we did in the earlier inquiry, namely from the altitudes and azimuths, following this diagram D. It agrees with diagram A above in almost everything, except that in this position of the comet the bright star of the Head

of Medusa stood toward the west with respect to the orbit. There is therefore no need to repeat the lines and letters one by one again, either of this figure or of all the remaining figures that follow; so let us set to work at once.

Investigation of Parallax II, from the distances of the comet and Algol, computed, for December 23 [Inveſtigatio Parallaxeos II. Ex diſtantiis Cometæ & Algol ſupputatis. Ad diem 23 Decembr.]

1st observation, hour	$7^h\ 22^m\ 7^s$ in the evening	Altitude of the comet	44° 28′ 0″	Azimuth, east	48° 19′		
2nd observation, hour	$11^h\ 28^m\ 0^s$ in the evening	Altitude of the comet	48° 4′ 45″	Azimuth, west	42° 14′		
Longitude of the comet at hour	$7^h\ 22^m\ 7^s$	28° 56′ 24″ ♉	Latitude of the comet	3° 0′ 21″ *A.*	Latitude of Algol	22° 22′ 30″	
Longitude of Algol		21° 21′ 0″ ♉	Quadrant of the circle	90° 0′ 0″	Complement to the quadrant	67° 37′ 30″	
Angle E A D		7° 35′ 24″	Distance from the pole A I	93° 0′ 21″			
Logarithm of the complement of the latitude of Algol, A E	7827				Antil. A E	96584	
Logarithm of the angle E A D	202433 *A.*						
Logarithm of the perpendicular E D	210260	7° 0′ 56″			Antilog.	752 *S.*	
					Antilog. A D	95832	67° 26′ 48″
Antilog. D I	10298					A I	93° 0′ 21″
Antilog. of the perpendicular E D	752 *A.*					D I	25° 33′ 33″
Antilog. E I	11050	26° 26′ 40″	Earlier distance of the comet and Algol				

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For the later distance [Pro Diſtantiâ poſteriore.]

[260] the calculation is set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the other rows stand bare on the page, and the marks are supplied here in the house form. The tags *A.* and *S.* are the page's own and are not expanded on the page. ♉ is the page's sign of Taurus.

Longitude of the comet at hour	$11^h\ 28^m\ 0^s$	28° 48′ 18″ ♉	Latitude of the comet	1° 30′ 56″ south	
Longitude of Algol		21° 21′ 0″ ♉	Quadrant of the circle	90° 0′ 0″	
Angle E A K		7° 27′ 13″ [?]	Side A L	91° 30′ 56″	

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Logarithm of the complement of the latitude of Algol, A E	7827		Antilog. A E	96584	
Logarithm of the angle E A K	204235 *A.*				
Logarithm of the perpendicular E K	212062	6° 53′ 23″	Antil.	725 *S.*	
			Antilog. A K	95859	67° 27′ 12″ *S.*
Antilog. K L	9090		Distance from the pole A L		91° 30′ 56″
Antilog. of the perpendicular E K	725 *A.*		K L		24° 3′ 44″
Antilog. of the distance E L	9825	24° 59′ 5″	of the later observation		
Earlier distance of the comet and Algol		26° 26′ 40″			
Difference of the distances		1° 27′ 35″			
Proper motion from the table		1° 13′ 46″			
Therefore the fictitious or mean parallax		13′ 49″			

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[Margin: Parallaxis media.] *The mean parallax.*

It would hardly be worth the effort to reduce these distances to the orbit, correcting and limiting them for the apparent motion, since the fixed star is so very close to the orbit that it is removed from it by scarcely a few minutes; and we also learned from the earlier calculation that there was scarcely 15″ of difference between the limited apparent motion and the fictitious one, although at that time the Heel stood a whole degree and more from the orbit. Nevertheless, so that you are not left in doubt whether this limitation can contribute even the least thing to the fictitious parallax, I shall not mind entering upon the calculations themselves on this matter, and indeed by the third method given above, the easiest of all, and the most suitable for distances in which the fixed

[261] set as the calculation above. "south" renders the page's *Auſt.*

[262] the calculation of p. 250 continues here, set unruled in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the other rows stand bare on the page, and the marks are supplied here in the house form. The tags *A.* and *S.* are the page's own and are not expanded on the page.

stars are very near the orbit. But first the distance, or latitude, of Algol from the comet's orbit must be explored.

For the reduction of the fictitious, or mean, parallax to the orbit [Pro reductione parallaxeos fictæ, ſeu mediæ ad orbitam.]

[Margin: Reductio ad orbitam.] *Reduction to the orbit.*

Longitude of Algol	21° 21′ 0″ ♉				
Point of intersection of the orbit and the ecliptic	28° 32′ 30″ ♉				
Difference G H	7° 11′ 30″	Antil.	790		
Latitude of Algol E G	22° 22′ 30″	Antil.	7827 *A.*	E G Log.	96584
Hypotenuse H E		Antil.	8617	23° 26′ 45″	Log. 92161 *S.*
Angle G H E				Log. 4423	73° 5′ 0″
Logarithm of the hypotenuse H E	92161			Angle of the orbit and the ecliptic	73° 58′ 30″
Logarithm of the angle E H F	416293 *A.*			There remains the angle E H F	53′ 30″
Logarithm of the distance E F	508454	21′ 17″	Algol from the comet's orbit, toward the west.		
Antil. of the hypotenuse, the earlier distance E L	26° 26′ 40″	1052.206			
Antil. of the distance of the star from the orbit	21′ 17″	1.916 *S.*			
Antil. of the reduced distance L F		11050.288	26° 26′ 32″		
Antil. of the hypotenuse, the later distance E I	24° 59′ 5″	9825.210			
Antil. of the distance of the star from the orbit	21′ 17″	1.917			
Antil. of the reduced distance I F		9823.293	24° 58′ 56″		
The apparent motion reduced to the orbit is therefore			1° 27′ 36″		
True motion from the table			1° 13′ 46″		
Therefore the parallax of the orbit			13′ 50″		

263

[Margin: Parallaxis Orbitæ cum mediâ planè eadem eſt hocce in exemplo.] *In this example the parallax of the orbit is entirely the same as the mean parallax.*

[263] set as the calculation above. ♉ is the page's sign of Taurus. The decimal points in the logarithms of the last rows are the page's own. The page prints "Rectat angulus" in the label rendered "There remains the angle"; the sense is that of "Restat".

From this it is perfectly clear, as we said at the beginning, that this parallax of the orbit is entirely the same as the fictitious, or mean, parallax, exceeding it by scarcely a single second; so that there would have been no need to carry out this limitation here. Indeed, even if you undertake the matter by the other methods, you will still extract no difference.

[Margin: Reducatur parallaxis Orbitæ ad verticalem.] *Let the parallax of the orbit be reduced to the vertical.*

Let us now go on with the calculation, however, and reduce this parallax of the orbit that has been found to the vertical, since we do not know whether the comet stood together with Algol precisely under one and the same vertical. But it is a great help to us that we already know, from the calculation above, from Figure B, the angle H C A, or I C G, of the orbit and the vertical, for 7^{h} 22^{m} 7^{s} in the evening: 1° 15′ 20″. It is therefore easy to reduce the parallax to the orbit.

Mesolog. of the side C G, or the parallax of the orbit	13′ 50″	551549 +	Subtract cossically.	
Antilog. of the angle I C G	1° 15′ 20″	24 +		
Mesolog. of the parallax C I, reduced to the vertical		551525 +		13′ 50″

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[Margin: Pro Proſthaphæreſi inclinationis inveniendâ.] *For finding the prosthaphaeresis of inclination.*

Next, for this parallax reduced to the vertical, let the corresponding prosthaphaeresis of inclination also be sought, so that the genuine equated vertical parallax may come out. For since the later distance, in the west, was not altogether parallel to the horizon, as indeed it necessarily should have been, both the first and the second prosthaphaeresis of inclination must be inquired into, as we did above; and both of them, likewise, are to be added according to axiom 1. Before we get there, however, let the altitude of Algol at 11^{h} 28^{m} 0^{s} in the evening be investigated first, and the rest in consequence.

1. To find the altitude of Algol, for December 23, at 11^{h} 28^{m}.

Right ascension of the Sun	273° 10′ 21″
Elongation from the meridian	172° 0′ 0″
	445° 10′ 21″
Right ascension of Algol	41° 23′ 0″

[264] set unruled, in the page's own columns: italic labels, roman figures and point-letters; a short rule stands under the figures that are subtracted. The signs + are the page's own. The degree, minute and second marks are printed only over some figures; the marks of the second row are supplied here in the house form.

		403° 47′ 21″			
Excess over the semicircle		43° 47′ 21″	Distance from the meridian, logarithm	36817	
Declination of Algol		39° 35′ 0″	Antilog.	26046 *A.*	
Logarithm of the declination B R	45067		Perpendicular B F, logarithm	62863	32° 13′ 46″
Antil. of the perpendicular B F	16733 *S.*				
Antil. S F	28334	41° 7′ 35″			
Complement of the elevation of the pole, S A		35° 37′ 0″			
A F		5° 30′ 35″	Antil.	463	
		B F	Antil.	16733 *A.*	
		A B, or B O	Antil.	17196	57° 21′ 13″ Altitude sought, of Algol.
					32° 38′ 47″ Complement of the altitude.

265

[Margin: Altitudo Algol ad hor. 11 28 min.] *The altitude of Algol at 11^h 28^m.*

2. To compute the angle B A C.

Complement of the altitude of the comet, C A	41° 55′ 15″	Log.	40332	
Complement of the altitude of Algol	32° 38′ 47″	Log.	61728 *Ad.*	
Difference	9° 16′ 28″		102060	Sum
Later distance of the comet and Algol	24° 59′ 5″			
Sum	34° 15′ 33″			
Half	17° 7′ 46″	Log.	122235	
Difference	15° 42′ 37″			
Half	7° 51′ 18″	Log.	199021 *A.*	
Later aggregate		Log.	321256	
Earlier aggregate			102060	
Difference			219196	
Half			109598	19° 31′ 28″
			Doubled	39° 2′ 56″ Angle sought, B A C

[265] set unruled, as the calculation above, with short rules under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form. The tags *A.* and *S.* are the page's own and are not expanded on the page.

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[Margin: Angulus quæſitus B A C.] *The angle sought, B A C.*

3. Investigation of the angle B A C, D C A, and of the angle of inclination.

Angle B A C	39° 2′ 56″	Log.		46206	
Complement of the altitude of Algol	32° 38′ 47″	Log.		61728 *A.*	
		Log.		107934	
Side 3. B C	24° 59′ 5″	Log.		86186 *S.*	
Of the angle B C A		Log.		21748	53° 34′ 0″ B C A.
Angle B A C	39° 2′ 56″	Log.		46206	
Complement of the altitude of the comet	41° 55′ 15″	Log.		40332 *A.*	
		Log.		86538	24° 53′ 28″ D E, perpendicular.
Complement of the altitude of the comet	41° 55′ 15″	Antil.		29562	
Perpendicular D E	24° 53′ 28″	Antil.		9749 *S.*	
		Antil.		19813	34° 53′ 23″ A E
		Complement of the altitude of the comet			41° 55′ 15″ A C
		Difference			7° 1′ 52″ E C
Of the side E C	7° 1′ 52″	Log.		210041 +	
Perpendicular D E	24° 53′ 28″	Mesol.		76787 +	
Of the angle D C A		Mesol.		133254 —	75° 13′ 18″ D C A
		Angle to be subtracted			53° 34′ 0″ B C A
		There results the first angle of inclination			21° 39′ 18″ D C B

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4. For the first prosthaphaeresis of inclination.

The parallax reduced to the vertical was	13′ 50″	Logar.	551525
Angle of inclination D C B	21° 39′ 18″	Logar.	99691 *A.*

[266] set unruled, as above. The tags *Ad.* and *A.* are the page's own and are not expanded on the page; the marks are supplied in the house form where the page prints the figures bare.

[267] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form. The tags *A.* and *S.* and the signs + and — are the page's own and are not expanded on the page.

	There results the prosthaphaeresis of the first inclination, B I		Logar.	651216	5′ 6″	
	Parallax reduced to the vertical				13′ 50″	*Add.*
	Therefore the genuine vertical parallax, first equated				18′ 56″	

[268]

5. For finding the second prosthaphaeresis of inclination, B D.

1	Hypotenuse C B, distance of the comet and Algol	24° 59′ 5″	Logar.	86186 *S.*		
	Perpendicular D E	24° 53′ 28″	Logar.	86538		
	Angle C B D, or H B C		Logar.	352	85° 11′ 40″	C B D.
2	Hypotenuse C B, distance of the comet and Algol	24° 59′ 5″	Logar.	86186		
	Angle of inclination D B C	21° 39′ 18″	Logar.	99691 *A.*		
	Perpendicular B I		Logar.	185877	8° 58′ 0″	B I
3	Hypotenuse C B, distance of the comet and Algol	24° 59′ 5″	Mesol.	76367 +	*S.* cossically.	
	Perpendicular B I	8° 58′ 0″	Mesol.	184650 +		
	Of the angle C B I		An- til.	108283 —	70° 13′ 0″	C B I
					85° 11′ 40″	I B D
	Angle sought, I B D				4° 58′ 40″	of inclination.
4	First prosthaphaeresis of inclination, B I	5′ 6″	Mesol.	651216 +		
	Angle of inclination I B D, found	4° 58′ 40″	An- til.	379 +		
	Second prosthaphaeresis of inclination, B D		Mesol.	650837 +	5′ 8″	*Add.*
	The parallax reduced to the vertical was				13′ 50″	
	Therefore the true vertical parallax, equated a second time				18′ 58″	

At the comet's altitude of 44° 28′, observed at $7^h\ 22^m\ 7^s$ on December 23.[269]

[Margin: Majoris certitudinis gratiâ denuò parallaxis ad eandem altitudinem inveſtigetur.] *For greater certainty, let the parallax be investigated again at the same altitude.*

And although this parallax agrees closely enough with the one found before, let us nevertheless go on to seek the parallax at exactly the same altitude from

[268] set as the calculation above. The tags *A.* and *Add.* are the page's own and are not expanded on the page.

[269] set as the calculation above; the part figures 1–4 stand at the left margin. The page subtracts 70° 13′ 0″ (C B I) from 85° 11′ 40″ and prints the remainder, the angle I B D, as 4° 58′ 40″; the difference of the two printed figures is 14° 58′ 40″. All three figures are printed as given here, and the next row repeats 4° 58′ 40″.

other observations in turn: keeping, indeed, the earlier vertical observation at $7^h\ 22^m\ 7^s$, but taking, in place of that later one obtained at $11^h\ 28^m$, an entirely different one, made at the hour namely $1^h\ 27^m\ 30^s$ of the 24th day; at which time the altitude and azimuth are likewise given; although in this observation, which is roughly parallel, a far smaller altitude, and on the other hand a far greater azimuth, was observed than in the preceding calculation. From these observations, I say, we shall hunt the matter down for the sake of greater certainty, investigating, therefore, the distances of the comet and the Heel again, so that from so great a variety the truth may become known the more correctly. But there is no need now to explore the earlier distance of the comet and the Heel again, because it was already computed in the first investigation, for the same time; only the later one, at $1^h\ 27^m\ 30^s$ in the morning, on the 24th.

Investigation of Parallax III, for December 23 [Inveſtigatio Parallaxeos I I I. Ad diem 23 Decembris.]

1.

On the 23rd, observation 1, at $7^h\ 22^m\ 7^s$ in the evening	Altitude of the comet	44° 28′	Azimuth	48° 19′ east	Vertical
On the 24th, observation 2, at $1^h\ 27^m\ 30^s$ in the morning	Altitude of the comet	33° 36′	Azimuth	75° 9′ west	parallax.

Longitude of the comet at $1^h\ 27^m\ 30^s$		28° 46′ 25″ ♑	Latitude of the comet		0° 57′ 21″ south
Longitude of the Heel		26° 17′ 12″ ♑	Quadrant of the circle		90° 0′ 0″
Difference, or angle E A K		2° 29′ 13″	Side A L		90° 57′ 21″
Logarithm of the complement of the latitude of the Heel, A E	2259	A E		Antil.	155975
Logarithm of the angle E A K	312748				
Logarithm of the perpendicular E K	315007	2° 27′ 21″		Antil.	92 *S.*
				Antil.	155883 A K 77° 51′ 23″
Antilogarithm K L	2636.640				A L 90° 57′ 21″
Antilog. of the perpendicular E K	91.897 *A.*				K L 13° 5′ 58″
Antilog. of the distance E L	2728.537	3° 19′ 25″	of the comet and the Heel.		
Earlier distance		15° 22′ 0″			
Apparent proper motion		2° 2′ 35″			
Proper motion from the table, for $6^h\ 5^m\ 23^s$ in the evening		1° 47′ 10″	and since this is less than the apparent motion, there is therefore given		

a parallax, by Theorem 1.	0° 15′ 25″

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2. For the reduction to the orbit: since both the distance of the Heel from the comet's orbit and also the earlier, limited distance of the comet are already known, the calculation is therefore completed without any trouble.

Antilog. of the distance E L	13° 19′ 25″	2728.537	
Antilog. of the distance of the Heel from the orbit, E F		22.528	
		S.	
Antil. of the later distance, reduced to the orbit		2706.00913° 16′ 9″	
The earlier distance, corrected and reduced, was			15° 19′ 10″
The apparent motion, reduced and corrected			2° 3′ 1″
True motion from the table, corresponding to the time between the two observations			1° 47′ 10″
Therefore the true parallax, reduced to the orbit			15′ 51″

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3. The reduction of the parallax to the vertical is also carried out with no great labour, since the angle of the orbit and the vertical, I C G, in diagram B above, has already become known on p. 191.

Mesolog. of the side C G, or the parallax of the orbit	15′ 51″	537940 +	*S.* cossically.	
Antilog. of the angle I C G, found above	1° 15′ 20″24 +			
Mesolog. of the parallax C I, reduced to the vertical		537916 +	15′ 51″	differs not at all from the parallax of the orbit above.

272

[Margin: Pro Proſthaphæreſi inclinationis.] *For the prosthaphaeresis of inclination.*

[270] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form. ♉ is the page's sign of Taurus. The tags *A.* and *S.* are the page's own and are not expanded on the page. "Vertical" and "parallax." stand one under the other at the right of the two observation lines. The "6 5′ 23″" of the proper-motion row is the interval between the two observations; the page sets "in the evening" after it.

[271] set as the calculation above.

[272] set as the calculation above; the signs + are the page's own. The words "differt planè" stand at the end of the last row and run on into the line beneath, "nihil à ſuperiori parall. orbit."

But for finding the prosthaphaeresis of inclination we cannot use any short cut here: for since these things fall to us to be worked out from an entirely new observation, namely at $1^h\ 27^m\ 30^s$, everything must be computed in order, according to our procedure; and indeed first the altitude of the Heel, so that we may not be ignorant whether the comet or the Heel stood higher.

1. To find the altitude of the Heel, at $1^h\ 27^m\ 30^s$, on December 24.

Right ascension of the Sun		273° 15′ 54″				
Elongation from the meridian		201° 52′ 30″				
Right ascension of the midheaven		475° 8′ 24″				
Right ascension of the Heel		50° 39′ 37″				
		424° 28′ 47″				
Excess over 360°, distance from the meridian		64° 28′ 47″	Logar.	10268		
Declination of the Heel		31° 7′ 38″	Antilog.	15546 *A.*		
			Logar.	25814	B F	50° 34′ 40″
Logarithm of the declination, B R	65983					
Antilog. of the perpendicular, B F	45409 *S.*					
Antilog. S F	20574	35° 30′ 30″ *S.*				
Complement of the elevation of the pole, S A		35° 37′ 0″				
A F		6′ 30″	Antilog.	0		
		B F	Antilog.	45409		
		B O, logarithm, or A B	Antilog.	45409	39° 25′ 18″	Altitude of the Heel.
					33° 36′ 0″	Altitude of the comet.
			Difference of the altitudes		5° 49′ 18″	

273

2. To compute the angle B A C.

[273] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form. The A F row prints "6 30" with no degree figure, under the minutes and seconds of the rows above; it is given here as 6′ 30″, with no degree figure supplied. The tags *A.* and *S.* are the page's own and are not expanded on the page.

Complement of the altitude of the comet, C A	56° 24′ 0″	Log.	18282	
Complement of the altitude of the Heel, B A	50° 34′ 42″	Log.	25814 *A.*	
Difference of the altitudes	5° 49′ 18″	Log.	44096	Earlier aggregate.
Bare distance of the Heel and the comet	13° 19′ 10″			
Sum	19° 8′ 24″			
Half	9° 34′ 14″	Logar.	179418	
Remainder	7° 29′ 52″			
Half	3° 44′ 56″	Logar.	272749 *A.*	
	Later aggregate		452167	
	Earlier aggregate		44096 *S.*	
	Difference		408071	Logarithm of the half-angle.
	Half		204035	7° 28′ 7″
			Angle B A C	14° 56′ 14″

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3. Investigation of the angle B A C, D C A, and of the angle of inclination.

Of the angle B A C	14° 56′ 14″	Log.	135573		
Complement of the altitude of the Heel	50° 34′ 42″	Log.	25814 *A.*		
		Log	161387		
Side B C, distance	13° 19′ 10″	Log.	146802 *S.*		
Of the angle B C A		Log.	14585	59° 58′ 4″	B C A
Angle B A C	14° 56′ 14″	Log.	135573		
Complement of the altitude of the comet	56° 24′ 0″	Log.	18282 *A.*		
		Log.	153855	12° 23′ 51″	D E, perpendicular.

275

Complement of the altitude of the comet, A D	56° 24′ 0″	Antil.	59169	

[274] set as the calculation above. The page prints the sum of 5° 49′ 18″ and 13° 19′ 10″ as 19° 8′ 24″; the two figures add to 19° 8′ 28″, and the half printed beneath, 9° 34′ 14″, is the half of 19° 8′ 28″.

[275] set as the calculation above; the calculation runs on overleaf.

Perpendicular D E	12° 23′ 51″	Antil.	2359 *S.*		
A E		Antil.	56810	55° 29′ 12″	A E
		Complement of the altitude of the comet		56° 24′ 0″	A C
		Difference		54′ 48″	E C
Side E C	0° 54′ 48″	Log.	413892 +	Subtract cossically.	
Perpendicular D E	12° 23′ 51″	Mesol.	151496 +		
Of the angle D C A		Mesol.	262396 —	85° 50′ 29″	D C A
				59° 58′ 4″	B C A
				25° 52′ 25″	D C B

276

4. For the first prosthaphaeresis of inclination.

Parallax reduced to the vertical	0° 15′ 51″	Logar.	537916	
Angle of inclination D C B	25° 52′ 25″	Logar.	82922 *A.*	
There results the prosthaphaeresis of inclination, B I		Logar.	620838	6′ 55″ *Add.*
			Parallax reduced to the vertical	15′ 51″
Therefore the vertical parallax, first equated, becomes				22′ 46″

277

Lastly, we shall also see whether the second prosthaphaeresis, B D, differs much from this first prosthaphaeresis, B I.

5. For finding the second prosthaphaeresis of inclination. Add.

[276] the calculation of step 3 continues here from the previous page, set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form. The Difference row prints "54 48" with no degree figure, under the minutes and seconds; it is given here as 54′ 48″, with no degree figure supplied, while the next row prints "0 54 48" and is given 0° 54′ 48″. The tag *S.* and the signs + and — are the page's own and are not expanded on the page.

[277] set as the calculation above.

1.	Hypotenuse C B, distance of the comet and the Heel	13° 19′ 10″	Logar.	146802 *S.*		
	Perpendicular D E	12° 23′ 51″	Logar.	153855		
	Of the angle C B D, or H B C		Logar.	7053	68° 44′	C B D
2.	Hypotenuse C B, distance of the comet and the Heel	13° 19′ 10″	Logar.	146802		
	Of the angle of inclination D C B	25° 52′ 28″	Logar.	82922 *A.*		
	Of the perpendicular B I		Logar.	2297245	5° 46′	B I
3.	Hypotenuse C B, distance of the comet and the Heel	13° 19′ 10″	Mesol.	144097 +	Subtract cossically.	
	Perpendicular B I	5° 46′ 0″	Mesol.	229275 +		
	Of the angle C B I		Antilog.	85178 —	64° 44′	C B I
			Angle to be subtracted		68° 44′	D B C
			Angle of inclination sought		4° 0′	I B D
4.	First prosthaphaeresis of inclination, B I	0° 6′ 55″	Mesol.	620838		
	Of the angle I B D, found	4° 0′ 0″	Antil.	244 *S.*		
	Second prosthaphaeresis of inclination, B D		Mesol.	6205946	6′ 56″	*A.*
			Parallax reduced to the vertical		15′ 51″	
			Therefore the true vertical parallax, equated a second time, is		22′ 47″	

[278]

You see, therefore, that this later prosthaphaeresis, B D, is greater by scarcely a single second; and — what very often happens — that the two are altogether equal to each other, especially when the angle D C A, or C D A, which is equal to it, is fairly large and nearly a right angle, as in this example, where it is given as about 85 degrees. And then B I is almost the same as B D, and that later equation does not change the parallax at all.

[Margin: Denuò alio calculo parallaxis ad diem 23Decemb. ſupputetur.] *Let the parallax for December 23 be computed again by another calculation.*

But since this genuine vertical parallax, equated a second time, exceeds those derived from the first and second calculations by one minute or another, we have proposed again, from other distances, namely those of the comet and Algol, observing, how- ever, the same earlier observations, to investigate the

[278] set as the calculation above; the part figures 1–4 stand at the left. The page prints the perpendicular B I bare, as "5 46" in part 2, under the "68° 44′" of part 1, and as "5 46 0" in part 3, under the degrees, minutes and seconds of "13 19 10"; the marks are supplied here by those columns.

parallax, so that by this means we may be made more certain of the true parallax of this 23rd day.

In this inquiry, moreover, it comes to our aid that there is now no need to investigate the earlier distance of the comet and Algol, since it was already obtained above; and also that in the reduction to the orbit only the later distance has to be limited. We could, indeed, omit even that altogether, given that the star Algol is very close to the orbit, so much so that it can introduce no difference: as you will clearly see for yourself, it produces, namely, scarcely two seconds. Furthermore, in the reduction to the vertical we shall likewise enjoy the earlier short cut, and in the whole calculation the same diagrams as in the second investigation.

Investigation of Parallax IV, Computed from the Distances of the Comet and Algol, for December 23 [Inveſtigatio Parallaxeos I V. Ex diſtantiis Cometæ & Algol ſupputatis. Ad diem 23 Decembr.]

Observation 1, at $7^h\ 22^m\ 7^s$ in the evening	Altitude of the comet	44° 28′	Azimuth	48° 19′ east
Observation 2, at $1^h\ 27^m\ 30^s$ in the morning	Altitude of the comet	33° 36′	Azimuth	75° 9′ west

For the later distance.

Longitude of the comet at $1^h\ 27^m\ 30^s$		28° 46′ 25″ ♑	Latitude of the comet	0° 57′ 21″ *A.*	Latitude of Algol	22° 22′ 30″ *S.*
Longitude of Algol		21° 21′ 0″ ♉		90° 0′ 0″	Complement of the altitude	67° 37′ 30″
Angle E A K		7° 25′ 25″	Side A L	90° 57′ 21″		
Logarithm of the complement of the latitude of Algol, A E	7827		A E Antil.	96584		
Logarithm of the angle E A K	204637 *A.*					
Logarithm of the perpendicular E K	212464	6° 51′ 43″	Antilog.	719 *S.*		
			Antilog.	95865	A K	67° 27′ 18″
Antilog. K L	8659				A L	90° 57′ 21″
Antilog. of the perpendicular E K	719 *A.*					
					K L	23° 30′ 3″
Antilog. of the distance E L	9378	24° 25′ 45″	Later distance.			
		26° 26′ 40″	Earlier distance, found in calculation 2			
		2° 0′ 55″	Apparent proper motion			

1° 47′ 10″	True proper motion from the table
13′ 45″	The fictitious or mean parallax.

279

[Margin: Parallaxis ficta.] *Fictitious parallax.*
For the reduction of the later distance to the orbit.

Antil. of the hypotenuse, the later distance	9378	
Antil. of the distance of Algol from the orbit	2 *S.*	
Antil. of the reduced distance L F	9376	24° 25′ 35″
The earlier distance, reduced, was		26° 26′ 32″
Apparent proper motion, limited or reduced		2° 0′ 57″
True proper motion from the table		1° 47′ 10″
Parallax of the orbit		13′ 47″

280

[Margin: Parallaxis orbitæ.] *Parallax of the orbit.*
It differs from the fictitious parallax by only two seconds; this reduction could therefore have been omitted without any harm.
For the reduction to the vertical.

Mesol. of the side C G, or the parallax of the orbit	13′ 47″	551911 +	*S.* cossically.	
Antilog. of the angle I C G	1° 15′ 20″	24 +		
Mesol. of the parallax C I, reduced to the vertical		551887 +	13′ 47″	differs not at all from the parallax of the orbit.

281

[279] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form. The last row prints "13 45" with no degree figure, under the minutes and seconds of the rows above; it is given here as 13′ 45″, with no degree figure supplied. ♉ is the page's sign of Taurus. The tags *A.* and *S.* are the page's own and are not expanded on the page. The label beside 67° 37′ 30″ is printed "Cōpl.altit."; the figure stands as 90° less the latitude of Algol, 22° 22′ 30″. The right-hand rows A K, A L and K L are set at their own spacing beside the left-hand rows.

[280] set as the calculation above; the last row prints "13 47" with no degree figure, under the minutes and seconds of the rows above.

[281] set as the calculation above; the signs + are the page's own. The words "nihil planè" stand at the end of the last row and run on into the line beneath, "differt à Parall. orbitæ."

[Margin: Parallaxis ad vertical. reducta.] *Parallax reduced to the vertical.*

[Margin: Proſtaph. inclinationis indagatur.] *The prosthaphaeresis of inclination is investigated.*

For the prosthaphaeresis of inclination, however, let the altitude of Algol first be sought, namely for the later observation, at $1^h\ 27^m\ 30^s$ on December 24, so that the difference between the altitudes of the comet and Algol may become known.

Right ascension of the Sun		273° 15′ 54″				
Elongation from the meridian		201° 52′ 30″				
Right ascension of the midheaven		475° 8′ 24″				
Right ascension of Algol		41° 23′ 0″				
		433° 45′ 24″				
Excess over 360°, distance from the meridian		73° 45′ 24″	Logar.	4073		
Declination of Algol		39° 35′ 0″	Antilog.	26046 *A.*		
Logarithm of the declination, B R	45067		Logar.	30119	B F	47° 43′ 37″
Antilog. of the perpendicular, B F	39649 *S.*					
Antilog. S F	5418	18° 41′ 27″ *S.*				
[?] Elevation of the pole, S A		35° 37′ 0″				
A F		16° 55′ 33″	Antilog.	4428		
			B F	39649		
			Antilog.	*A.*		
			B O	44077	40° 3′ 22″	Altitude of Algol.
			Logar.			
					33° 36′ 0″	Altitude of the comet.
					6° 27′ 22″	Difference.

282

[Margin: Altitudo Algol ad diem 24 Decemb.] *The altitude of Algol for December 24.*

2. To compute the angle B A C.

[282] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form. A small point stands before the 73 of the excess over 360°. The label of the row S A is printed with a short tick before it, and its first letter is not clear between E and F; the figure 35° 37′ 0″ is the one p. 205 gives as the complement of the elevation of the pole. The tags *A.* and *S.* are the page's own and are not expanded on the page.

Complement of the altitude of the comet, C A	56° 24′ 0″	Log.	18282	
Complement of the altitude of Algol, B A	49° 56′ 38″	Log.	26734 *A.*	
Difference of the altitudes	6° 27′ 22″	Log.	45016	Earlier aggregate.
Distance of the comet and Algol	24° 25′ 30″			
Sum	30° 52′ 52″			
Half	15° 26′ 26″	Logar.	132335	
Remainder	17° 58′ 8″			
Half	8° 59′ 4″	Logar.	185684 *A.*	
	Later aggregate		318019	
	Earlier aggregate		45016 *S.*	
	Difference		273003	
	Logarithm of the half-angle		136001	14° 52′ 19″
			Angle B A C	29° 44′ 38″

283

3. Investigation of the angle B A C, D A C, and of the angle of inclination of the parallax, D C B.

Of the angle B A C	29° 44′ 38″	Logarithm.	70090		
Complement of the altitude of Algol	49° 56′ 38″	Logarithm.	26734 *A.*		
Sum		Logarithm.	96824		
Side 3 B C	24° 25′ 30″	Logarithm.	88308 *S.*		
Of the angle B C A		Logarithm.	8516	66° 41′ 20″	B C A
Angle B A C	29° 44′ 38″	Logarithm.	70090		
Complement of the altitude of the comet	56° 24′ 0″	Logarithm.	18282 *A.*		
Perpendicular D E		Logarithm.	88372	24° 24′ 30″	D E
Complement of the altitude of the comet	56° 24′ 0″	Antilogar.	59169		
Perpendicular D E	24° 24′ 30″	Antilogar.	9362 *S.*		
A E		Antilogar.	49807	52° 34′ 37″	A E
		Complement of the altitude of the comet		56° 24′ 0″	A C
				3° 49′ 23″	E C

[283] set as the calculation above. The distance of the comet and Algol is printed here as 24° 25′ 30″, where p. 207 gives the later distance as 24° 25′ 45″ and, reduced to the orbit, 24° 25′ 35″.

Side E C	3° 49′ 23″	Logarithm.		270791 +	Subtract cossically.	
Perpendicular D E	24° 24′ 30″	Mesologar.		79010 +		
Of the angle D C A		Mesologar.		191781 —	81° 31′ 29″	D C A
					66° 41′ 20″	B C A
					14° 50′ 9″	D C B

284

[Margin: Angulus inclinationis.] *The angle of inclination.*

4. For the first prosthaphaeresis of inclination.

Parallax reduced to the vertical	13′ 47″	Logar.	551887	
Angle of inclination D C B	14° 50′ 9″	Logar.	136238 *A.*	
There results the first prosthaphaeresis of inclination, B I		Logar.	688125	3′ 32″ *Add.*
			The parallax reduced to the vertical was	13′ 47″
			Therefore the genuine vertical parallax, first equated	17′ 19″

285

[Margin: Parallaxis primò coæquata.] *The parallax first equated.*

5. For finding the second prosthaphaeresis of inclination, likewise additive, according to our Axiom I.

1	Hypotenuse C B, distance of the comet and Algol	24° 25′ 30″	Logar.	88308 *S.*		
	Perpendicular D E	24° 24′ 30″	Logar.	88372		
	Angle C B D, or H B C		Logar.	64	87° 57′ 0″	D B C.

[284] set as the calculation above; the signs + and — are the page's own. The step heading names the angles "B A C, D A C", as printed. The side B C is labelled "Later. 3 B C", with the figure 3 as printed. In the row A C the 0 of 56° 24′ 0″ is crossed by a stroke, and a short upright mark follows the letters A C.

[285] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form. The last two rows print "13 47" and "17 19" with no degree figure, and none is supplied. The tag *A.* is the page's own and is not expanded on the page.

2	Hypotenuse C B, distance of the comet and Algol	24° 25′ 30″	Logar.	88308		
	Angle of inclination D C B	14° 50′ 9″	Logar.	136238 *A.*		
	Perpendicular B I		Logar.	224546	6° 4′ 41″	B I
3	Hypotenuse C B, distance of the comet and Algol	24° 25′ 30″	Mesol.	78972 +	*S.* cossically.	
	Perpendicular B I	6° 4′ 41″	Mesol.	223986 +		
			Antil.	145014 +	76° 27′ 52″	C B I
			Angle to be subtracted		87° 57′ 0″	D B C
			Angle of inclination sought		11° 29′ 8″	I B D
4	First prosthaphaeresis of inclination, B I	3′ 32″	Mesol.	688125 +		
	Angle I B D	11° 29′ 8″	Antil.	2023 +		
	Second prosthaphaeresis of inclination, B D		Mesol.	686102 +	3′ 36″	*Add.*
			Parallax reduced to the vertical		13′ 47″	
			The true vertical parallax, equated a second time		17′ 23″	

For the altitude of the comet of 44° 28′, on December 23, at 7^h 22^m 7^s in the evening.[286]

[Margin: Vnde difcrepantia calculi exorta ſit, & quinam calculus præferendus.] *Where the discrepancy in the calculation arose from, and which calculation is to be preferred.*

It is therefore clear that this parallax is somewhat smaller than the one found in the preceding calculation, although it was computed for the same time and the same altitude, from the same observations and by the same method. Meanwhile, however, I prefer this parallax to the one sought from the distances of the Heel: not only because it agrees better with the parallaxes found in the first and second investigations, but also for this reason, that the star Algol was far closer to the comet's orbit than the Heel was.

[Margin: Declinationes Fixarum nondum omnibus numeris ſunt determinatæ.] *The declinations of the fixed stars have not yet been determined in every respect.*

[286] set as the calculation above; the part figures 1–4 stand at the left. The perpendicular B I is printed bare as "6 4 41" in parts 2 and 3, under the degrees, minutes and seconds of the rows above, and is given 6° 4′ 41″ by those columns. In part 4 the first prosthaphaeresis is printed "3 32" with no degree figure, under the minutes and seconds, and none is supplied. The signs + are the page's own. The italic line beneath the calculation begins "Ad alti-" at the end of its last row and runs on into the line below.

Moreover, it is certain that some slight difference can easily intrude here, on account of the declinations and right ascensions belonging to the different fixed stars. For I have no doubt that the declinations and right ascensions of all fixed stars whatsoever, and especially of the smallest, have not been observed equally well and accurately, even by Tycho himself (which, however, I would say with all respect to the reputation of so great a man). You too will gladly agree with me on this, if you weigh properly whatever we have noted at length about the declinations of the fixed stars in our *Machina*, soon to be published: namely, that the declinations even of the stars of the first rank have not all been duly determined by Tycho, but still need some correction. The table of the declinations and longitudes of the fixed stars by the most learned Riccioli, inserted near the end of Book VI, Chapter XIV, bears witness to this.

[Margin: AtteſtanteRi[?]ciolo.] *On the testimony of Riccioli [?].*

[Margin: Dato aliquo vitio in declinatione Fixarum datur etiam in ſupputatione parallaxium.] *Given some fault in the declination of the fixed stars, there is one also in the computation of the parallaxes.*

Given, therefore, some slight fault in the declination of this or that fixed star, there is one likewise in the longitude and latitude; and consequently, from this source too, by several seconds, indeed sometimes by a whole minute and more, in this or that compu- tation of the parallax from the distances of this or that fixed star and the comet, it is very easy to go astray; so that it is almost impossible, in every investigation, always to derive the parallaxes to the very same seconds from the distances of any fixed stars whatever, even from exactly the same observations.

[Margin: Quibus inſuper de cauſis differentiola aliquot ſecundorum calculo ſe ſe ingerere poſſit.] *For what further reasons a slight difference of several seconds may intrude into the calculation.*

In addition, mathematicians mostly use logarithms to 5 figures; and there it can very easily happen, especially in those monstrous triangles, that here and there we either lose or gain several seconds, which afterwards, in the course of the calculation, either decrease or increase. So it is no wonder that, when some appreciable parallax is given, that difference can extend to one minute or another. To say nothing of the case where still other obstacles arise concerning the positions of the distances: for example, where the parallaxes are somewhat opposed to each other and conflict. About these, and some other precautions to be observed with the greatest care in undertaking the calculation of parallaxes from distances, we shall shortly add more, as this occasion offers.

[Margin: Quòd adeò præciſè parallaxes congruant, demirandum eſt.] *That the parallaxes agree so precisely is to be wondered at.*

There is therefore no reason for you to wonder that some slight difference sometimes arises between these same parallaxes; nor is there reason, on that account, either to accuse the calculator of negligence or to ascribe it to the method of computing. Rather, what is truly to be wondered at is that parallaxes derived from such various and diverse observations, altitudes and azimuths,

from distances both observed and computed, by a different method and a most extensive calculation, still agree with one another so precisely.

But before we pass on to the fifth investigation, I shall give you, as I just promised, certain remarks: namely, which observations and distances should be chosen in order to examine the parallaxes the more accurately. For it is not a matter of indifference whether one submits the distance of this fixed star or that to the calculation of parallaxes; and this not only for the reasons brought forward here and there in the preceding pages, but above all for the following ones, which, on my advice, a careful calculator must always attend to most closely.

[Margin: Animadverſiones quædam ſelectæ, circa calculum ex diſtantiis ſuſcipiendum maximè notabiles.] *Certain selected remarks, most worth noting, on undertaking the calculation from distances.*

1. When the comet is higher in the earlier, vertical observation than in the later, parallel observation — that is, when the comet is continually ascending from the first observation up to the second — it is better and safer to use the distances of those fixed stars which the comet is then approaching. The reason is that at the time when the comet is lower in the first, vertical observation, where that distance is always greater, and again higher in the second, parallel observation, where this distance is always smaller, the comet can never corrupt the true and apparent distance less; especially if, about the parallel distance, the comet stood somewhat lower than the fixed star.
2. But those distances should count for less with you, with the comet in the same position described, when the comet is receding. For then the parallaxes are carried in the opposite direction: namely when, in the earlier, vertical observation, at a smaller distance, the comet is lower, and conversely, in the later, parallel observation, at a greater distance, the comet is higher; especially if, in addition, the comet was much higher than the fixed star in the later, parallel observation.

From this it follows that when sometimes, for lack of observations and distances, or on account of a less convenient position of the comet, such distances as are actually wanted are not available for the calculation, then — even granting that the computation of the parallax is set up for the same time and from the same longitudes and latitudes of the comet — it is altogether impossible for the parallaxes to agree to the very seconds, and indeed sometimes even within one minute or another, from whatever distances are assumed: whether greater or smaller; whether the comet is approaching or receding; whether the fixed star lies under the orbit itself and in the same vertical, or far from the orbit and in different verticals; likewise, in the parallel distance, whether the comet was higher or lower than the fixed star; and no less from the same distances taken perpendicular to the comet and its orbit, whether in the earlier, roughly perpendicular distance the comet is approaching or receding; and again, in the later one, with the comet placed either higher or lower, both with respect to

itself and to the fixed star. In all such widely different configurations of the comet, I say, a slight difference can sometimes arise — namely, when we rely on less suitable distances.

[Margin: Niſi convenientes obſervationes & diſtātias pro eruendis parallaxibus adhibeas, negotium vix pro voto ſuccedit.] *Unless you employ suitable observations and distances for deriving the parallaxes, the business hardly succeeds as one would wish.*

Yet this method of deriving parallaxes is so far from being of less value than the others that, in my judgement at least, it should rather be held far more precious, since this method attends to everything so accurately that it at once registers even the smallest things that occur. For that reason everyone who undertakes this parallactic labour certainly has cause to observe the more accurately each and every point I have remarked, whether now or elsewhere. And if some slight difference shows itself in the seconds, or in some minute, he should not at once spurn the whole business and dismiss it as worthless, as the Peripatetics mostly do in celestial matters (for they reject a thing before they rightly understand it). Rather, he should learn from these points where that slight difference originates; likewise, which distances and observations are more to be trusted; what kind of distances and observations should be chosen for the calculation in preference to the rest; and which parallaxes are the truest of all those derived.

[Margin: Modus noſter eliciendi parallaxes neutiquam a pernandus.] *Our method of deriving parallaxes is by no means to be spurned.*

[Margin: Quare & quando nihil interſit an parallaxis aliquot minutis minor vel major ſit ?] *Why and when it makes no difference whether a parallax is smaller or greater by a few minutes.*

Finally, I add that it makes no difference whether some horizontal parallax is greater or smaller by 3, 4 or 6 minutes, so long as the horizontal parallax does not exceed a whole degree — to say nothing of the case where it is far smaller. For on that account the comet will not suddenly be placed either below or above the Moon. Riccioli agrees with us here, as can be seen in Book VIII, Section I, on comets, page 72 of Volume II of the *Almagestum*: *"Secondly, I ask that it not be put down to captious or sophistical inquiry — as though we were looking for knots in a bulrush — if we require that degree of subtlety in determining the parallax which is necessary for the evidence described above; for although, in the parallax itself, once it is established that it is many minutes greater or smaller than the lunar parallax, a difference of one minute or another harms neither party* (that is, neither those who hold the comet to be ethereal nor those who hold it to be aerial)."

[Margin: Quintâ Inveſtigatione demonſtratur ritè deducta eſſe omnia.] *By a fifth investigation it is shown that everything has been duly derived.*

So that even less ground for doubt may remain about this parallax of December 23 — that it really was by no means greater than we have just computed — here, finally, is its fifth investigation: from exactly the same observations,

both vertical and parallel, namely at $7^h\ 22^m\ 7^s$ in the evening and $1^h\ 27^m\ 30^s$ in the morning, but sought from entirely different distances, namely those of the comet and Palilicium. And this, not only for the reason that, in the earlier observation, that fixed star likewise stood almost in the same vertical as the comet, so that conversely in the la- ter observation it lay almost even more parallel to the horizon than the Heel and Algol; but also because the comet was receding with respect to this fixed star, just as it was approaching the preceding ones, and because Palilicium was somewhat farther from the orbit and had a southern latitude. Since the configuration of the comet and the fixed star was thus entirely different — indeed, on the opposite side — it will be all the more clearly evident, in computing the parallax, whether any error was committed in the preceding investigations. But if from these distances too there comes out exactly the same parallax, equal to those computed before, then it is quite certain that the parallaxes for this day, December 23, have been derived most exactly.

Investigation of Parallax V, from the Distances of the Comet and Palilicium, Computed for December 23 [Inveſtigatio Parallaxeos V. Ex diſtantiis Cometæ & Palilicii ſupp. ad diem 23 Decemb.]

Observation 1, at $7^h\ 22^m\ 7^s$ in the evening	Altitude of the comet	44° 28′	Azimuth 48° 19′ east	vertical
Observation 2, at $1^h\ 27^m\ 30^s$ in the morning	Altitude of the comet	33° 36′	Azimuth 75° 9′ west	parallel

Longitude of the comet, observation 1			28° 56′ 24″	Latitude of the comet	3° 0′ 21″	Latitude of Palilicium	5° 29′ 57″ G E
Longitude of Palilicium			4° 57′ 8″	Complement	86° 59′ 39″	Its complement	84° 30′ 3″ A E
Difference B G, or angle E A K			6° 0′ 44″				
Logarithm of the complement of the latitude of Palilicium	A E	461		A E Antil.	234516		
Logarithm of the angle	E A K	225628 *A.*					
Logarithm of the perpendicular	E K	2260895° 59′ 4″		Antil.	546 *S.*		
Antilogarithm	K I	97			233970	A K	84° 28′ 14″
Antilog. of the perpendicular	E K	546 *A.*				A I	86° 59′ 39″
Antilog. of the distance	E I, earlier	643	6° 29′ 20″	of the comet and Palilicium		K I	2° 31′ 25″

2.

Longitude of the comet, observation 2			28° 46′ 25″ ♉	Latitude of the comet	0° 57′ 21″ south	C L	
Longitude of Palilicium			4° 57′ 8″ ♊	Complement	89° 2′ 39″	A L	
Difference C G, or angle E A D			6° 10′ 43″				
Logarithm of the complement of the latitude of Palilicium	A E	461		A E Antil.	234516		
Logarithm of the angle	E A D	222907 *A.*					
Logarithm of the perpendicular	E D	223368	6° 9′ 0″	Antil.	577 *S.*		
Antil.	D L	319			233939	A D	84° 28′ 8″
Antil. of the perpendicular	E D	577 *A.*				A L	89° 2′ 39″
Antil. of the distance	E L	896	7° 39′ 30″	Later distance of the comet and Palilicium		D L	4° 34′ 31″
			6° 29′ 20″	Earlier distance of the comet and Palilicium			
Difference of the distances			1° 10′ 10″	or the fictitious apparent motion			

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[Margin: Motus visus fictus.] *Fictitious apparent motion.*

Before we go further, however, we must first correct the distances found — that is, the apparent motion — by first investigating the distance of Palilicium from the orbit, from the accompanying figure D d. This distance was very considerable in relation to the distances of both bodies, and as a result, as you will see, the apparent motion will be increased not a little. Yet in this example it will come out smaller than the true motion, even though parallax is present in the observations, in accordance with the fifth axiom given above on page 180.

Longitude of Palilicium	64° 57′ 8″		
Point of intersection of the orbit and the ecliptic	58° 32′ 30″ H	*for December 23*	
Difference G H	6° 24′ 38″	Antil.	627
Latitude of Palilicium[288], south	5° 29′ 57″	Antil.	461 *A.*
	8° 26′ 15″	Antil.	1088 H E

[287] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. ♉ and ♊ are the page's signs of Taurus and Gemini. The tags *A.* and *S.* are the page's own and are not expanded on the page. The figure "2." stands alone, centred above the second part. The right-hand rows A K, A I, K I and A D, A L, D L are set at their own spacing beside the left-hand rows.

[288] the page inks "Paliic."; recte: Palilic.

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Diagram. An engraved geometric figure within a ruled plate-mark, set in the lower right of the text block beside the paragraph above. A horizontal line across the top is the ecliptic, labelled "Ecliptica" beneath it at the left; along it stand G at the left and B, C, H at the right. A long curved line descends from G through E down to A at the foot; two near-vertical lines descend from B and C. A straight line from H runs down to the left past L, I, K and a lower letter (F or E), and is labelled "Orbit. Com." (orbit of the comet) along its length. E is a star, labelled "Palil." (Palilicium) to its left; straight lines join E to L and to I, dotted lines join E to H, to K, to D and to the lower letter, and a dotted line joins M, on E L, to I. L and I are drawn as small circles. The figure is marked "D d." at the right, and "Autor ſculps." (the author engraved it) at the lower right inside the plate-mark.

- G (top left, on the ecliptic)
- B, C, H (top right, on the ecliptic)
- Ecliptica (below the top line, left): the ecliptic
- L (upper right, small circle on the orbit)
- M (on the line E L)
- I (small circle, below L)
- Palil. (left of E): Palilicium
- E (star, left)
- K (below I)
- D (right, below K)
- F or E [?] (below D, on the orbit line; the lowest stroke is crossed by a line of the figure)
- Orbit. Com. (along the slanting line): orbit of the comet
- D d. (right of the figure): the figure's mark
- A (foot)
- Autor ſculps. (lower right): the author engraved it

Logarithm	H E, hypotenuse	191916	*S.*		
Logarithm	E G	234519			
Logarithm	G H E	42603	40° 46′ 30″		
Angle of the orbit and the ecliptic	F H G		73° 58′ 30″		
There remains the angle	E H F		33° 12′ 0″	Logarith.	60228

[289] set unruled, as the calculation above; short rules stand under "58 32 30" and under "461 A.". The first two rows carry the degree, minute and second marks over the figures; in the others the marks are supplied here in the house form.

			Log. 191916 H E *A.*	
			Log-a-rith. 252144	4° 36′ 30″ Distance E F of Palilicium from the orbit
Antilog. of the hypotenuse, the earlier distance	E I	6° 29′ 20″	643	
Antilog. of the distance of Palilicium from the orbit	F E	4° 36′ 30″	324 *S.*	
Antilog. of the distance reduced, or	I F		319	4° 34′ 30″
Antilog. of the hypotenuse, the later distance	L E	7° 39′ 30″	896	
Antilog. of the distance of Palilicium from the orbit	F E	4° 36′ 30″	324 *S.*	
Antilog. of the distance reduced, or	F L		572	6° 7′ 2″
		Apparent motion reduced, or corrected		1° 32′ 50″
At 6^h 5^m 23^s in the evening		True motion from the table		1° 47′ 10″
		Since, therefore, the true motion is greater than the apparent, in this position of the comet the parallax reduced to the orbit becomes		14′ 20″

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[Margin: Parallaxis orbitæ.] *Parallax of the orbit.*

The reduction to the vertical is carried out as before, from the same figure B above, and from the angle H C A, or I C G, found there.

Mesol. of the side C G, or parallax of the orbit	14′ 20″	547998

[290] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. The label of the distance E F stands at the right of three rows on the page. The last row is set on the page as an italic line running from "quia igitur" at the end of the row above. The tags *A.* and *S.* are the page's own and are not expanded on the page. The row F L prints "6 7 2" in its third group; see the QA note.

Antilog. of the angle	I C G	1° 15′ 20″	24 *S.*
Mesol. of the parallax reduced to the vertical	C I	14′ 20″	547974

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To find the prosthaphaeresis of inclination, however, a different construction and a complete calculation are needed, because of the very different position of Palilicium relative to the comet in the later, parallel observation.

Diagram. An engraved figure within a plate-mark, set in the right part of the text block. A circle carries A at the top, S at the upper right, Q and F at the upper left, P, M and X on the left, and G and L on the right. A star stands at B, with H and D below it and I and R further down; a small circle marks C, with E above and to the right of it. The comet's orbit, labelled "Orbita Cometa", runs as a curve from the left through C to G; the ecliptic, "Ecliptica", descends to the right through E; the horizon, "Horizon", is the curve from M to L, with K and O below it; a line from P descending to the right is labelled "[?]quator" (the equator). "Occidens." (west) stands inside the circle below the horizon, and the figure's mark "E." below it. Dotted lines join B to F, and B, H and D to C and E. "Autor fculps." (the author engraved it) stands at the lower right of the plate-mark.

- A (top of the circle)
- S (upper right)
- Q, F (upper left)
- P (left)
- B (star)
- H, D (below B)
- E (above and right of C)
- I, R (below D)
- C (small circle)
- Orbita Cometa (along the curve through C to G): orbit of the comet
- G (right)
- Ecliptica (along the descending line through E): the ecliptic
- Horizon (along the curve M–L): the horizon
- M (left), L (right)
- K, O (below the horizon)
- X (lower left)
- Æquator or Aquator [?] (along the line from P): the equator; the first letter is not settled
- Occidens. (inside the circle, below the horizon): west
- E. (below): the figure's mark

[291] set as the calculation above; a short rule stands under "24 S.". The first row carries the minute and second marks; in the others the marks are supplied in the house form. The third row prints "14 20" with no degree figure, under the minutes and seconds of the first row, and none is supplied.

• Autor fculps. (lower right): the author engraved it

1. For finding the altitude of Palilicium at $1^h\ 27^m\ 30^s$ in the morning.

Right ascension of the Sun			273° 15′ 54″			
Elongation from the meridian			21° 52′ 30″			
Right ascension of the midheaven			295° 8′ 24″			
Right ascension of Palilicium			64° 1′ 45″			
			231° 6′ 39″			
Excess over 180, the distance from the meridian			51° 6′ 39″	Logar.	25056	
Declination of Palilicium			15° 46′ 12″	Antilog.	3837 *A.*	
Logar. of the declination	B R	130278		B F Logar.	28893	48° 30′ 35″
Antil. of the perpendicular	B F	41176 *S.*		B F Antil.	41176	
Antil.	S F	89102	65° 46′ 48″			
Complement of the elevation of the pole	S A		35° 37′ 0″ *S.*			
	A F		30° 9′ 48″	Antil.	14550 *A.*	
				B K Logarithm	55726	34° 56′ 39″ Altitude of Palilicium
						33° 36′ 0″ Altitude of the comet
				Difference of the altitudes		1° 20′ 39″

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[Margin: Altitudo Palilicii ad hor. 1 27 min. 30 Sec.] *The altitude of Palilicium at $1^h\ 27^m\ 30^s$.*

Since, therefore, the difference of the altitudes is very slight, the prosthaphaeresis of inclination will accordingly also come out small; and in this case it is, conversely, additive, according to our fifth axiom of prosthaphaereses.

2. To compute the angle B A C.

Complement of the altitude of the comet, C A	56° 24′ 0″	Loga-rithm.	18282

[292] set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own and are not expanded on the page; the *S.* after 35° 37′ 0″ is printed there. The heading of step 1 is set roman, centred, on two lines.

Complement of the altitude of Palilicium, B A	55° 3′ 21″	Logarithm.	19881 *Ad.*	
Difference of the altitudes	1° 20′ 39″		38163	Earlier aggregate.
Bare later distance of the comet and Palilicium	7° 39′ 30″			
Sum	9° 0′ 9″			
Half	4° 30′ 4″	Logarithm.	254493	
Difference	6° 18′ 51″			
Half	3° 9′ 25″	Logarithm.	289913 *A.*	
Later aggregate		Logarithm	544406	
Earlier aggregate			38163 *S.*	
	Logarithm of the half-angle		506243	4° 33′ 48″
			253121	9° 7′ 36″ The whole angle B A C sought.

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3. Investigation of the angle B C A, D C A, and of the angle of inclination of the parallax, D C B.

Angle B A C	9° 7′ 36″	Logarithm.	184126	
Complement of the altitude of Palilicium	55° 3′ 21″	Logarithm.	19881 *A.*	
Sum		Logarithm.	204007	
Side 3 B C, distance B C	7° 39′ 30″	Logarithm.	201541 *S.*	
Of the angle B C A		Logarithm.	2466	77° 19′ 40″ B C A.
Angle B A C	9° 7′ 36″	Logarithm.	184126	
Complement of the altitude of the comet	56° 24′ 0″	Logarithm.	18282 *A.*	
Perpendicular D E		Logarithm.	202408	7° 35′ 30″ D E
Complement of the altitude of the comet	56° 24′ 0″	Antilogarith.	59169	
Perpendicular D E	7° 35′ 30″	Antilogarith.	880 *S.*	
		Antilogarith.	58289	56° 3′ 47″ A E

293 set unruled, in the page's own columns: italic labels, roman figures and point-letters; short rules stand under the figures that are added or subtracted. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. The tags *Ad.*, *A.* and *S.* are the page's own and are not expanded on the page; the second row prints *Ad.* where the matching row of p. 258 prints *A.* The label of the angle B A C stands on two lines at the right of the last row.

		Complement of the altitude of the comet		56° 24′ 0″	A C
Side E C	20′ 13″	Logarithm.	513605 +	20′ 13″	E C
Perpendicular D E	7° 35′ 30″	Mesologar.	201530 +		
Of the angle D C A		Mesologar.	312075 —	87° 28′ 25″	D C A
				77° 19′ 40″	B C A
			Angle of inclination sought	10° 8′ 45″	D C B

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4. For the first prosthaphaeresis of inclination.

Parallax reduced to the vertical, B C	0° 14′ 20″	Logarithm.	547974		
Angle of inclination, D C B	10° 8′ 45″	Logarithm.	173640 *A.*		
First prosthaphaeresis of inclination, B I		Logarithm.	721614	2′ 32″	*Add.*
			The parallax reduced to the vertical was	14′ 20″	
			Therefore the vertical parallax, first equated	16′ 52″	

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[Margin: Parallaxis primò coæquata.] *The parallax first equated.*

Now we shall likewise see whether the genuine second prosthaphaeresis also undergoes some change — which, however, I think can hardly happen, since the angles A C D and C D A now approach a right angle, and the first prosthaphaeresis amounts to only about two minutes. Nevertheless, let us test it by calculation.

5. For finding the true prosthaphaeresis of inclination B D, *add.*

1.	Hypotenuse C B, distance of the comet and Palilicium	7° 39′ 30″	Logar. 201541 *S.*	

294 set as the calculation above; the signs + and — are the page's own. The side E C is printed "20 13" in both places, under the minutes and seconds of the rows above, with no degree figure, and none is supplied. The side B C is labelled "Later.3.B C", with the figure 3 as printed.

295 set as the calculation above. The first row prints the degree figure "0" with its mark, and it is kept. The last two rows print "14 20" and "16 52" with no degree figure, and none is supplied.

	Perpendicular C H, or D E		7° 35′ 30″	Logar. 202408	
	Of the angle H B C, or C B D			Logar. 867	82° 28′ D B C

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2.	Hypotenuse C B, distance of the comet and Palilicium	7° 39′ 30″	Logar.	201541	
	Of the angle of inclination D C B	10° 8′ 45″	Logar.	173640 *A.*	
	Of the perpendicular B I		Logar.	375181	1° 21′ B I
3.	Hypotenuse C B, distance of the comet and Palilicium	7° 39′ 30″	Mesol.	200644 + *Subt. Cos.*	
	Perpendicular B I	1° 21′ 0″	Mesol.	374794 +	
	Of the angle C B I		Antilog.	174150 +	79° 54′ C B I
			Angle to be subtracted		82° 28′ D B C
			Angle of inclination sought		2° 34′ I B D
4.	Prosthaphaeresis of inclination, first equated	0° 3′ 32″	Mesol.	721614 +	
	Of the angle I B D	2° 34′ 0″	Antil.	100 + *S.*	
	Prosthaphaeresis of inclination B D, second equated		Mesol.	721514 +	2′ 32″ *A.*
			Parallax reduced to the vertical		14′ 20″
			Therefore the genuine vertical parallax, second equated		16′ 52″ exactly as above.
			At the altitude of the comet 44° 28′, on December 23, at 7^{h} 22^{m} 7^{s}.		

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[296] set as the calculation above; the part figure "1." stands at the left. The angle D B C is printed "82 28" with degree and minute marks and no seconds figure, and none is supplied. The calculation runs on overleaf.

[297] set unruled, in the page's own columns, continuing the calculation of step 5; the part figures "2.", "3.", "4." stand at the left. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. The fourth part prints the first prosthaphaeresis as "0 3 32", where the preceding page prints it 2′ 32″ beside the same logarithm 721614; the figure is kept as printed. The signs + and the tags *A.*, *S.* and *Subt. Cos.* are the page's own and are not expanded on the page. "exactly as above" renders "planè ut ſuprà", printed on two lines.

[Margin: In hoc calculo, parallaxis ſecunda omninò eſt æqualis primæ.] *In this calculation the second parallax is altogether equal to the first.*

You see, then, that nothing whatever has accrued to the first prosthaphaeresis from this computation; rather, the first and the second prosthaphaeresis have turned out exactly the same, and consequently the parallax second equated is also in every way equal to the parallax first equated. Moreover, it agrees as well as could be with the parallax found by calculations 1 and 4, so that it differs by scarcely a few seconds, although it was sought from such different principles and observations.

Let this be amply sufficient on the parallaxes of the 23rd, derived by this method from the distances; now let us likewise inquire how great the parallaxes of the remaining, following days were. Next, the order would indeed require us to apply the same care to December 24 and 25; but because the sky was very cloudy and observations were lacking, we had to pass over these days and proceed at once to the 26th. Let us see, then, whether the parallax remains of the same size, or whether it gradually, with the passage of time, increases or decreases.

[Margin: Ad diem 26 Decembr. parallaxes inquiruntur ex Cometæ & Palilicii diſtantiis.] *For December 26 the parallaxes are investigated from the distances of the comet and Palilicium.*

For examining the parallaxes of this day, the 26th, we have observations of various kinds: both distances taken with the sextant itself, and others obtained from azimuths and altitudes at very different times. From all of these we shall now examine the parallaxes, sometimes even with one distance observed and the other derived by calculation — something that until now, indeed, was possible only from computed distances alone.

[Margin: An ex diſtantiis omninò æqualibus diverſo tempore captis parallaxis erui poſſit ?] *Whether a parallax can be derived from altogether equal distances taken at different times?*

First there presents itself one distance of the comet and Palilicium, at 9^{h} 0^{m} 34^{s} in the evening, and another a little later, at 10^{h} 13^{m} 30^{s}, which we measured with the sextant — both of exactly the same size, 21° 32′. It is, indeed, an extremely remarkable thing that both turned out of altogether equal size, although the later distance was observed 1^{h} 12^{m} 56^{s} later. Surely the later distance just mentioned ought rightly to have been somewhat greater than the earlier, since the comet was receding with respect to Palilicium. It will therefore seem almost impossible to some how a parallax could be investigated from these entirely equal distances, in which no difference — no mean or fictitious apparent motion — is detected. Yet, in my opinion, it can be done very well. We must not, however, be ignorant of the position in which the comet was seen relative to Palilicium at that time, in each observation.

[Margin: Poſitus Cometæ ad Palilicium.] *The position of the comet relative to Palilicium.*

In the earlier, eastern observation, at $9^h\ 0^m\ 34^s$, near the meridian, the comet stood above Palilicium, though not in one and the same vertical; nor did the vertical coincide exactly with the orbit. In the later, western observation, at $10^h\ 13^m\ 30^s$, the comet was by no means at the same distance from the horizon as the fixed star, but was raised about 12 degrees above Palilicium. Consequently, because of the parallax, which depresses the comet towards the star, the later distance came out somewhat smaller than it really should have been if it had stood at a wholly equal interval either from the horizon or from the vertical point — especially since in the later observation the comet was a little lower than in the earlier one.

But it is clearly established that the comet had a proper motion, such that in the interval of time that elapsed between the two observations, namely $1^h\ 12^m\ 56^s$, it must necessarily have advanced 10′ 57″ further — that is, moved away from the fixed star — as our table of proper motion shows. The later distance should therefore also have exceeded the earlier by altogether that much, namely 10′ 57″. But since this turned out otherwise, and both distances came out of equal size, it is certainly the parallax, depressing the comet towards Palilicium, that makes the later distance smaller by the same amount.

[Margin: Hoc in caſu motus proprius Cometæ eſt ipſa parallaxis media.] *In this case the proper motion of the comet is itself the mean parallax.*

And so, if we consider the matter more deeply, the proper motion itself, 10′ 57″, is here the mean or fictitious parallax; for this proper motion is equivalent to the difference of the distances, or of the apparent and the true motion, as will become rather clearer from the calculation itself. The first part of the calculation is very easy and pleasant, because here the distance of the comet and Palilicium need not be investigated; by contrast, the later part of the calculation will seem the more laborious and tedious, because there the altitudes as well as the azimuths of both the comet and the fixed star have to be computed. The task will therefore involve almost the same labour.

Investigation of Parallax VI, from the Distances of the Comet and Palilicium Taken with the Sextant, for December 26, Evening [Inveſtigatio Parallaxeos V I. Ex diſtantiis Cometæ & Palil.Sextante Captis. Ad diem 26 Decemb. veſp.]

1.	Obser-vation	at $9^h\ 0^m\ 34^s$	Distance of the comet and Palilicium	21° 32′	
2.	Obser-vation	at $10^h\ 13^m\ 30^s$	Distance of the comet and Palilicium	21° 32′	
			Therefore the difference of the distances, or	0	the fictitious apparent motion.

298

[Margin: Quomodo procedendum ſit ubi nulla differentia diſtantiarum datur.] *How to proceed where there is no difference of the distances.*

According to our usual practice, the distances ought now indeed to be reduced to the orbit itself, so as to derive the corrected, or limited, apparent motion. But since both distances are altogether equal in size, and there is no difference between them, this can in no way be done; the matter must therefore be accomplished in an entirely different way. First, this difference of the distances, 0, is to be regarded as if it were — as indeed it really is — the apparent motion of the comet. But in such a configuration relative to the fixed star, namely with the comet above the fixed star and receding from it, this apparent motion is, by axiom 5, smaller than the true motion. Let this apparent motion, 0, therefore be subtracted from the true motion taken from the table, 10′ 57″: the mean or fictitious parallax comes out exactly as great, 10′ 57″. Let us reduce it to the orbit by a new but nonetheless safe method, by means of the angle F I E in the following figure F, or G C E in figure G, and the distance of Palilicium from the orbit; these must therefore be sought first. The distance mentioned above we have indeed already investigated for the 23rd; but to investigate it afresh is neces- sary, because the angle of the orbit and the ecliptic, and also the point of intersection, change little by little from day to day — although the values already found could safely be retained, since the parallax to be derived will be vitiated by almost nothing, at most 1″ or 2″, even if for the 26th you compute both that angle and the point of intersection again most exactly.

1. For finding the distance from the orbit.

Longitude of Palilicium		4° 57′ 8″ ♊			
Point of intersection of the orbit and the ecliptic		28° 31′ 0″ ♉			
Difference G H		6° 26′ 8″	Antilogar.	633	
Latitude of Palilicium, G E		5° 29′ 57″	Antilogar. *A.*	461	
Hypotenuse H E			Antilogar.	1094	8° 27′ 36″
Logar. H E, hypotenuse	191651 *S.*		Logarithm.	191651	
Logar. E G	234516				
Logar. of the angle G H E	42865	40° 38′ 43″			
Angle of the orbit and the ecliptic		73° 57′ 0″			
There remains the angle E H F		33° 18′ 17″	Logarith. *A.*	59949	

[298] set unruled, in the page's own columns; the second line's figures stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. Short rules stand under the second distance.

Of the distance E F	Loga-rith.	251600	4° 38′ 0″ of Palilicium from the orbit

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[Margin: Diſtantia Palil.ab Orbita.] *The distance of Palilicium from the orbit.*

2. For the angle I F E.

Log. of the hypotenuse E I, the earlier distance of the comet and Palilicium	21° 32′ 0″	100228 *S.*	
Log. of the distance of Palilicium from the orbit, E F	4° 38′ 0″	251600	
Log. of the angle F I E, or, in the following diagram G, E C G		151372	12° 42′ 52″

300

With these preliminaries settled, let the angle of the orbit and the declination, H C D or G C D, likewise be computed, and also the angle B C S, or I C D, in the following figure G, together with the angle I C G. Before these can be found, however, we must first compute the altitude and azimuth of the comet at $9^h\ 0^m\ 34^s$ in the evening, for this earlier investigation.

3. For finding the altitude and azimuth of the comet at $9^h\ 0^m\ 34^s$ in the evening.

Right ascension of the Sun		276° 23′ 48″			
Elongation from the meridian		135° 8′ 30″			
Right ascension of the midheaven		51° 32′ 18″	360 degrees cast off.		
Right ascension of the comet		48° 23′ 24″			
Distance from the meridian		3° 8′ 54″	Logar.	290188	
Declination of the comet		31° 55′ 29″	Antilog.	16400 *A.*	
Logar. of the declination, C I	63713		Logar.	306588	C F 2° 40′ 18″ in the following diagram H
Antilog. of the perpendicular C F	108 *S.*		C F Antilog.	108	
Antilog. S F	63605	58° 2′ 12″ *S.*			
Complement of the elevation of the pole, S A		35° 37′ 0″			

[299] set unruled, in the page's own columns. The signs of Gemini and Taurus stand after the first two values, as printed. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own and are not expanded on the page.

[300] set as the calculation above.

A F		22° 25′ 12″ Antilog.		7859 *A.*	
Logar. of the distance from the meridian	290188		C O Logar.	7967	67° 26′ 0″ Altitude of the comet.
Antilogar. of the declination	16400 *A.*				
Sum	306588				
Antil. of the altitude	95774 *S.*				
Logar. of the azimuth of the comet	210814	6° 58′ 35″			

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[Margin: Altitudo & Azimuth. Cometæ,ad hor. 9 0 min. 34 ſec.] *The altitude and azimuth of the comet at* $9^h\ 0^m\ 34^s$.

4. For the angle E C I in figure G.

Angle of the orbit and the equator	63° 1′ 0″	Antilog.	79025		
Declination D C	31° 55′ 29″	Antilog.	16400 *S.*		
Angle of the orbit and the declination		Logarith.	62625	32° 19′ 0″ H C D, or G C D.	
Complement of the elevation of the pole	35° 37′ 0″	Logarith.	54067		
Of the azimuth	6° 58′ 35″	Logarith.	210814 *A.*		
		Logarith.	264881		
Complement of the declination, C B	58° 4′ 31″		16400 *S.*		
Angle of the vertical and the declination		Logarith.	248481	4° 56′ 50″ B C S, or I C D	*add.*
			Angle of the orbit and the vertical	37° 5′ 50″ G C I	in this case.
			Angle of the orbit of the comet and the distance of Palilicium	12° 42′ 52″ E C G	*Add.*
			There results, therefore, the angle sought, E C I	49° 48′ 42″	

[301] set as the calculations above. ”in the following diagram H” renders ”in ſubſeq. Schem. H”, printed on two lines at the right of the seventh and eighth rows.

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In this way you can, in one operation, reduce the mean parallax, 10′ 57″, both to the orbit and to the vertical — provided, that is, that in our usual way E C is the parallax in the right triangle C E I, and the hypotenuse C I is investigated.

Mesolog. of the side C E, or fictitious parallax	10′ 57″	574923	
Antilog. of the angle E C I	49° 48′ 42″	43805	
		S.	
Mesol. of the parallax reduced to the orbit and the vertical together		531118	16′ 58″

303

[Margin: Parallaxis ad orb. & vertic. reducta.] *The parallax reduced to the orbit and the vertical.*

Diagram. One engraved plate within a plate-mark, across the full measure, holding three figures side by side, marked F, G and H, each set out for one observation; "Autor fculps." (the author engraved it) stands at the lower right of the plate-mark.

Figure F, at the left: three long curved lines descend from A at the top and spread out towards a lower arc running across from G through H, B and C; a further line, labelled "Orbita." (orbit) along its length, crosses them. Small circles mark L and I on the lines; dotted lines run from K to L and from D, past M, to I, K and D standing on the left-hand curve. Below the arc, E stands beside a star at the lower left; straight lines run up from E towards I and L, a dotted line joins E to H, and a dotted line runs from E to F at the foot of a line labelled "Cometæ" (of the comet), the label engraved upside down.

Figure G, in the middle: a circle with A at the top and R to its right; a line from B, outside the circle above, descends through A to C, marked by a small circle, and S stands at the upper left, joined to it by a dotted line. Within the circle, the ecliptic, "Ecliptica.", runs from Q at the left; Palilicium, "Palil." E, is a star on it, with G below; the equator, "Aquator.", runs from M, with H, D and I standing along it; the horizon, "Horizon.", runs from M to L, with K below it. Lines join C to I, to D and to H. "Meridies." (south) and the figure's mark G stand in the lower half; N stands on the right-hand edge, and X at the lower left, where the comet's orbit, "Orbit. Comet.", begins. Beneath the circle: "Hor. 9 0′ 34″ v." ($9^h\ 0^m\ 34^s$, evening).

[302] set unruled, in the page's own columns. The degree, minute and second marks are printed only over some rows; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. A tall printed bracket joins "*add.*" to "in this case" (the page's "hoc loco"). The tags *A.*, *S.*, *add.* and *Add.* are the page's own. The angle G C I is printed "37 5 50", where 32° 19′ 0″ and 4° 56′ 50″ above give 37° 15′ 50″; the sum below, 49° 48′ 42″, follows from 37° 5′ 50″; the figures are kept as printed.

[303] set as the calculation above; the parallax is printed "10 57" and the result "16 58" with minute and second marks and no degree figure, and none is supplied.

Figure H, at the right: a circle with A at the top, F, Q and V on the upper left, S and G on the upper right, P and X on the left, and L at the right end of the horizon, "Horizon.", which runs from M; K and O stand below the horizon. The comet's orbit, "Orbita Cometæ.", runs from C, marked by a small circle, to G; E, B, H, w and D stand close below C, with R and I further down at the left. Dotted lines run from V and from F towards the lines through C, and join B to H and D. Below the horizon stand "Occidens." (west) and the figure's mark H; the equator, "Aquator.", and the ecliptic, "Ecliptica.", descend to the right, to T and N on the circle. Beneath the circle: "Hor.10 13′ 30″ V." ($10^h\ 13^m\ 30^s$, evening).

- Figure F: A, "Orbita.", F (figure mark), K, L, D, M, I, G, H, B, C, E, F, "Cometæ".
- Figure G: S, B, A, R, C, "Ecliptica.", "Palil.", E, G, I, D, H, "Aquator." (equator), "Horizon.", Q, M, L, K, "Meridies.", G (figure mark), N, X, "Orbit. Comet.", "Hor. 9 0′ 34″ v.".
- Figure H: A, F, Q, S, G, V, P, E, C, "Orbita Cometæ.", B, H, w, D, R, I, X, M, L, K, O, "Horizon.", "Occidens.", H (figure mark), "Aquator.", "Ecliptica.", T, N, "Hor.10 13′ 30″ V.".
- "Autor ſculps." at the lower right.

Moreover, now that the parallax has thus been reduced to the orbit, it must now also be limited in the western quadrant, by investigating its prosthaphaeresis of inclination, since the comet stood much higher than Palilicium. Before this can be done, however, we must have ready to hand the altitudes of the comet and of the fixed star for the time of the later observation, $10^h\ 13^m\ 30^s$. Let us therefore now go and seek them.

For finding the altitude of the comet.				For finding the altitude of Palilicium.		
At $10^h\ 13^m\ 30^s$				At $10^h\ 13^m\ 30^s$		
Right ascension of the Sun	276° 30′ 18″			276° 30′ 18″		
Elongation from the meridian	153° 22′ 30″ *A.*			153° 22′ 30″ *A.*		
Right ascension of the midheaven	69° 52′ 18″60 degrees cast off.			69° 52′ 18″		
Right ascension of the comet	48° 20′ 0″		Right ascension of Palilicium	64° 1′ 45″		
Distance from the meridian	21° 32′ 18″	Logarith. 100217		5° 50′ 33″	Log-a-rith.	228482
Declination of the comet	32° 5′ 0″	Antilog. 16518 *A.*		15° 46′ 12″	An-tilog.	3837 *A.*

C F	18° 8′ 0″	Logarith.	116735	B V	5° 37′ 20″	Log-a-rith.	232319

304

Logar. of the declination	C I	63271		Log. of the declination	B R	130278	
Antilog. of the perpendicular	C F	5093 *S.*		Antilog.	B V	482 *S.*	
Antilog.	S F	58178	S F 56° 1′ 30″	Antilog.		12979674	° 9′ 0″ S V
Complement of the elevation of the pole	S A		35° 37′ 0″	Complement of the elevation of the pole			35° 37′ 0″ S A
	A F		20° 24′ 30″				38° 32′ 0″ V A
Antilog.	A F	6477		Antilog.	V A	24559	
Antilog.	C F	5093 *A.*		Antilog.	V B	482 *A.*	
Antilog.	A C	11570	62° 58′ 0″ alt. of the comet	Antilog.	A B	25041	51° 7′ 17″ alt. of Palilicium
							62° 58′ 0″ alt. of the comet
							11° 50′ 43″ Difference

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[Margin: Hocce in exemplo Proſtha. inclinat. ſubtractiva eſt.] *In this example the prosthaphaeresis of inclination is subtractive.*

Since, therefore, the comet is much higher than Palilicium, a quite considerable prosthaphaeresis of inclination will certainly result — and, according to the fifth axiom, a subtractive one.

For the angle B A C.

[304] two calculations set side by side, the comet's at the left and Palilicium's at the right, each under its own heading; the label of Palilicium's right ascension stands in the middle of the line, before its figures. The degree, minute and second marks are printed only over the first row of figures; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. In both columns the right ascension of the midheaven is printed 69 52 18, where 276° 30′ 18″ and 153° 22′ 30″, less 360°, give 69° 52′ 48″; the differences below follow from 69° 52′ 18″; the figures are kept as printed. In Palilicium's logarithm of the distance from the meridian one figure is not settled between 3 and 8, marked [?].

[305] two calculations set side by side, the comet's at the left and Palilicium's at the right, continuing the pair begun at the foot of the previous page. The degree, minute and second marks are printed only over the third row; the others stand bare on the page, and the marks are supplied here in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own.

Complement of the altitude of the comet, C A	27° 2′ 0″	Log.	78854	
Complement of the altitude of Palilicium, B A	38° 52′ 43″	Log.	46573 *A.*	
Difference of the distances	11° 50′ 43″	Log.	125427	Earlier aggregate.
Distance of the comet and Palilicium, B C	21° 32′ 0″			
Sum	33° 22′ 43″			
Half	16° 41′ 21″	Logar.	124765	
Remainder	9° 41′ 17″			
Half	4° 50′ 38″	Logar.	247168 *A.*	
Later aggregate			371933	
Earlier aggregate			125427 *S.*	
Remainder			246506	
Half			123253	16° 57′ 4″ Half-angle
Whole angle B A C				33° 54′ 8″

306

3. Investigation of the angles C B A, D B A and D B C, the angle of inclination of the parallax.

Of the angle B A C	33° 54′ 8″	Logarithm.	58379	
Complement of the altitude of the comet, A C	27° 2′ 0″	Logarithm.	78854 *A.*	
		Logarithm	137233	
Side 3 B C	21° 32′ 0″	Logarithm.	100228 *S.*	
		Logarithm.	37005	43° 41′ 8″ A B C
Angle B A C	33° 54′ 8″	Logarithm.	58379	
Complement of the altitude of Palilicium, A D	38° 52′ 43″	Logarithm.	46573 *A.*	
		Logarithm.	104952	20° 29′ 38″ D E, perpendicular
Complement of the altitude of Palilicium, A D	38° 52′ 43″	Antilogar.	25042	
Perpendicular D E		Antilogar.	6538 *S.*	
A E		Antilogar.	18504	33° 47′ 30″ A E
				38° 52′ 43″ A B
Side E B	5° 5′ 13″	Logarithm.	242286 + *S.* cossically	5° 5′ 13″ E B
Perpendicular D E	20° 29′ 38″	Mesologar.	98412 +	
Of the angle D B A		Mesologar.	143874 —	76° 93′ 16″ D B A
				43° 41′ 8″ A B C
		The angle of inclination sought		32° 58′ 8″ D B C

[306] set unruled, in the page's own columns; the heading is printed without a step number. The marks are printed only over the first row and over the half-angle; the rest are supplied in the house form; no figure is supplied.

307

4. For the first prosthaphaeresis of inclination.

Parallax reduced to the vertical, B C	16′ 58″	Loga-rithm.	531118	
Angle of inclination, D B C	32° 58′ 8″	Loga-rithm.	60847 *A.*	
First prosthaphaeresis of inclination, C W		Loga-rithm.	591965	9′ 14″ *Subt.*
The parallax reduced to the vertical was				16′ 58″
Therefore the vertical parallax, first equated				7′ 44″

308

[Margin: Parallaxis primò coæquata verticalis.] *The vertical parallax, first equated.*

5. For finding the second prosthaphaeresis of inclination, in this case subtractive.

1	Hypotenuse C B, distance of the comet and Palilicium	21° 32′ 0″	Logar.	100228 *S.*	
	Perpendicular D E or B H	20° 29′ 38″	Logar.	104952	
	Angle B C D, or B C H		Logar.	4724	72° 32′ 0″ D C B.
2	Hypotenuse C B, distance of the comet and Palilicium	21° 32′ 0″	Logar.	100228	
	Angle of inclination D B C	32° 58′ 8″	Logar.	60847 *A.*	
	Perpendicular C W		Logar.	161075	11° 31′ 0″ C W
3	Hypotenuse C B, distance of the comet and Palilicium	21° 32′ 0″	Mesol.	92993 + *S.* cossically	
	Perpendicular C W	11° 31′ 0″	Mesol.	159083 +	
	Angle sought, B C W		Antil.	66090 +	58° 54′ 0″ B C W
					72° 32′ 0″ B C D
			The angle of inclination sought		13° 38′ 0″ W C D

[307] set as the calculation above. The marks are printed only over the first row and over 43 41 8; the rest are supplied in the house form; no figure is supplied. The signs + and — after the logarithms are the page's own. In the row for the perpendicular D E at the right, the first figure of the seconds is an under-inked sort, read 3 (probable; a second copy would confirm); the same quantity is printed 20 29 38 at the left two rows below. The angle D B A is printed 76 93 16, a minutes figure above 60; 43° 41′ 8″ and 32° 58′ 8″ give 76° 39′ 16″; the figure is kept as printed.

[308] set as the calculations above; the marks are printed over 16 58 and 9 14 only, the rest supplied in the house form; the last two values are printed without a degree figure, and none is supplied.

4	First prosthaphaeresis of inclination, C W	0° 9′ 14″	Mesol.	591965 +	
	Angle of inclination W C D	13° 38′ 0″	Antil.	7858 +	
	Second prosthaphaeresis of inclination, C D		Mesol.	584107 +	9′ 59″ *Subtrah.*
	The parallax reduced to the vertical was				16′ 58″
	Therefore the genuine vertical parallax, equated a second time				6′ 59″

For the altitude 67° 26′ at $9^h\ 0^m\ 34^s$, observed on December 26.[309]

The calculation therefore shows clearly that the parallax of this day, the 26th, is somewhat smaller than that of the 23rd. Whether this is really so or not, let us inquire by a further, different investigation: namely with the same earlier distance of the comet and Palilicium, observed with the sextant at $9^h\ 0^m\ 34^s$, but with another added in place of the later one, which is to be computed from the altitude and azimuth observed at $11^h\ 38^m\ 22^s$. In this way we shall not always rely on the same distances and the same observations, and the matter will be made clearer to everyone. The later distance must therefore first be investigated from the longitudes and latitudes, as we have been accustomed to do.

[Margin: Parallaxis diei 26 minor eſt illâ ad diem 23 inventâ.] *The parallax of the 26th is smaller than that found for the 23rd.*

Investigation of Parallax VII, from the Distances of the Comet and Palilicium, One Observed and the Other Sought by Calculation, for December 26, Evening [Inveſtigatio Parallaxeos VII. Ex diſtantiis Cometæ & Palilicii, alterâ obſervatâ, alterâ ex calculo, quæſitâ. Ad diem 26 Decemb. veſp.]

1. Observation at $9^h\ 0^m\ 34^s$. Observed distance of the comet and Palilicium 21° 32′, east.
2. Observation at $11^h\ 38^m\ 22^s$. Altitude of the comet 52° 36′ 30″; azimuth 71° 22′, west.

Longitude of the comet at the later observation	24° 33′ 33″	Latitude of the comet, C L	13° 41′ 27″ north	Latitude of Palilicium	5° 29′ 57″ south
Longitude of Palilicium	4° 57′ 8″	Complement, A L	76° 18′ 33″	Distance from the pole	95° 29′ 57″ A

[309] set unruled, in the page's own columns, with the part figures 1–4 at the left as printed. The marks are printed only over the first row, over 72 32 0 and over 9 59; the rest are supplied in the house form; the last three values are printed without a degree figure, and none is supplied; the first prosthaphaeresis is printed with a leading 0, as kept. The signs + are the page's own. The closing words "Ad altitudinem … obſerv." are printed after the last value and run onto a second line.

Difference, or the angle L A K		10° 23′ 15″			
Logar. of the complement of the latitude of the comet, A L	2882	76° 18′ 33″	An-til.	144104	
Logar. of the angle L A K	171311 *A.*				
Log. of the perpendicular L K	174193	10° 5′ 22″	An-til.	1559 *S.*	
Antilogarithm K E	5851		An-til.	142545	A K 76° 5′ 23″
Antilog. of the perpendicular L K	1559 *A.*				A E 95° 29′ 57″
Antilog. of the distance L E	7410	21° 47′ 10″ later distance of the comet and Palilicium			K E 19° 24′ 34″
The other, observed distance		21° 32′ 0″ at 9^h 0^m 34^s			
Difference of the distances		15′ 10″ or the fictitious, or mean, apparent motion.			

310

[Margin: Motus visus medius.] *Mean apparent motion.*

But since Aldebaran declines somewhat from the orbit, this mean apparent motion must be corrected. This too can be done without difficulty, namely by means of the distance of the fixed star from the orbit, already investigated in the preceding calculation.

Reduction of the mean apparent motion to the orbit.

Antilog. of the later distance	21° 47′ 10″ L E	7410		
Antil. of the distance of the star from the orbit	4° 38′ 0″ F E	327 *S.*		
Antil. of the earlier distance, reduced	L F	7083	21° 18′ 40″	
Antil. of the earlier distance	21° 32′ 0″ I E	7235		
Antil. of the distance of Palilicium from the orbit	4° 38′ 0″ F E	327 *S.*		
Antil. of the earlier distance, reduced	F I	6908	21° 3′ 10″	*Subt.*
Apparent motion of the comet reduced to the orbit			15′ 30″	
True motion from the table, *comp.* for 2^h 37^m 48^s			24′ 19″	
Therefore the true parallax of the orbit			8′ 49″	

310 set unruled, in the page's own columns; the signs of Taurus and Gemini stand after the two longitudes, as printed. The marks are printed only over the first row, over 76 18 33 in the fourth row, over 76 5 23 and in the time; the rest are supplied in the house form; no figure is supplied. The difference of the distances is printed "15 10" without a degree figure, and none is supplied. The tags *A.* and *S.* are the page's own.

311

[Margin: Parallaxis Orbitæ.] *The parallax of the orbit.*

Let this parallax be reduced once more to the vertical. This too is done very easily, with the help of the preceding figure G, for the angle of the vertical and the orbit is also known from the earlier calculation.

Mesol. of the side C G, or the parallax of the orbit	8′ 49″	596593	
Antilog. of the angle G C I	37° 5′ 50″	22615 *S.*	
Mesol. of the complement of the hypotenuse C I, the parallax reduced to the vertical		573978	11′ 3″

312

To find the prosthaphaeresis of inclination in the western region, let the altitude of Palilicium at $11^h\ 38^m\ 22^s$ first be computed from diagram H, so that the difference between its altitude and the comet's may be clear, and so that from this we may at the same time learn the character of the prosthaphaeresis of inclination.

Right ascension of the Sun	276° 30′ 18″				
Elongation from the meridian	174° 35′ 30″				
Right ascension of the midheaven	91° 5′ 48″	360 degrees cast off.			
Right ascension of Palilicium	64° 1′ 45″				
Distance from the meridian	27° 4′ 3″		Logar.	78737	
Declination of Palilicium	15° 46′ 12″		Antilog.	3837 *A.*	
Logar. of the declination, B R	130278		Logar.	82574	25° 58′ 14″ B V
Antil. of the perpendicular B V	10645 *S.*	B V	Antil.	10645	
Antil. S V	119633	72° 24′ 34″			
Complement of the elevation of the pole, S A		35° 37′ 0″ *S.*			

311 set unruled, in the page's own columns. The marks are printed only over the first row, over 21 18 40 and in the time; the rest are supplied in the house form; the last three values are printed without a degree figure, and none is supplied. The tags *S.*, *Subt.* and *comp.* are the page's own.

312 set as the calculation above; the parallax is printed ”8 49” and the result ”11 3” with minute and second marks and no degree figure, and none is supplied.

V A	36° 47′ 34″	Antil.	22215 *A.*	
	B R	Logarithm.	32860	46° 2′ 52″ Altitude of Palilicium
		Altitude of the comet		52° 36′ 30″
		Difference of the altitudes of the comet and Palilicium		6° 33′ 28″

313

For the angle B A C.

Complement of the altitude of the comet, C A	37° 23′ 30″	Logarithm.	49881	
Complement of the altitude of Palilicium, B A	43° 57′ 8″	Logarithm.	36520 *Ad.*	
Difference	6° 33′ 38″		86401	Earlier aggregate.
Distance of the comet and Palilicium	21° 47′ 10″			
Sum	28° 20′ 48″			
Half	14° 10′ 24″	Logarithm.	140709	
Remainder	15° 13′ 32″			
Half	7° 36′ 46″	Logarithm.	202135 *A.*	
Later aggregate			342844	
Earlier aggregate			86401 *S.*	
Difference			256443	
Half			128221	16° 16′ 23″ Half-angle
The angle sought, B A C				22° 12′ 46″

314

Investigation of the angles C B A, D B A and D B C, the angle of the parallactic inclination.

Angle B A C	32° 12′ 46″	Logarithm.	62910

313 set unruled, in the page's own columns. The marks are printed only over the first row and over 25 58 14, 72 24 34 and 46 2 52; the rest are supplied in the house form; no figure is supplied. The difference of the altitudes is printed 6 33 28, where 52° 36′ 30″ less 46° 2′ 52″ gives 6° 33′ 38″, the value the next calculation uses; the figure is kept as printed.

314 set as the calculation above. The marks are printed only over the first row and over the half-angle; the rest are supplied in the house form; no figure is supplied. The tag after 36520 is printed *Ad.*, where the page elsewhere sets *A.*. The angle B A C is printed 22 12 46, where the half-angle 16° 16′ 23″ doubled gives 32° 32′ 46″; the figure is kept as printed.

Complement of the altitude of the comet	A C	37° 23′ 30″	Logarithm.	49881 *A.*	
			Logarithm.	112791	
Side 3. B C		21° 47′ 10″	Logarithm.	99117 *S.*	
			Logarithm.	13674	60° 42′ 50″ A B C. *Of the angle*
Angle B A C		32° 12′ 46″	Logarithm.	62910	
Complement of the altitude of the comet	A D	43° 57′ 8″	Logarithm.	36520 *A.*	
			Logarithm.	99430	21° 42′ 53″ D E, perpendicular
Complement of the altitude of Palilicium	A D	43° 57′ 8″	Antilogarith.	32862	
Perpendicular	D E	21° 42′ 53″	Antilogarith.	7360 *S.*	
	A E		Antilogarith.	25502	39° 12′ 15″ A E
			Complement of the altitude of Palilicium		43° 57′ 8″ A B
Side E B, *Subt.* cossically		4° 44′ 53″	Logarithm.	249160 +	4° 44′ 53″ E B
Perpendicular D E		21° 42′ 53″	Mesologar.	92069 +	
Of the angle D B A			Mesologar.	157091 —	78° 15′ 29″ D B A
					60° 42′ 50″ A B C
			The angle of inclination sought		17° 32′ 39″ D B C

315

For the first prosthaphaeresis of inclination.

Parallax reduced to the vertical, B C	0° 11′ 3″	Logar.	573978	
Angle of inclination D B C	17° 32′ 39″	Logar.	119921 *A.*	
There results the first prosthaphaeresis of inclination, C W		Logar.	693899	3′ 20″ *Subt.*
The parallax reduced to the vertical was				11′ 3″
Therefore the vertical parallax, first equated				7′ 43″

[315] set unruled, in the page's own columns; the heading is printed without a step number. The marks are printed only over the first row and over 60 42 50; the rest are supplied in the house form; no figure is supplied. The second complement, beside A D, is labelled for the comet on the page, where the next row labels the same figure for Palilicium; both labels are kept as printed. The signs + and — are the page's own. The angle B A C is printed 32 12 46 here, where the previous page prints 22 12 46 and its half-angle 16° 16′ 23″ would give 32° 32′ 46″; the figures are kept as printed.

316

[Margin: Parallaxis primò coæquata.] *The parallax first equated.*

Although, in my judgment at least, the second prosthaphaeresis of inclination changes the parallax found only very slightly, let us nevertheless set out the whole calculation, so that you may see this properly for yourself.

For investigating the genuine prosthaphaeresis of inclination, B D, in this case to be subtracted.

1.	Hypotenuse C B, distance of the comet and Palilicium	21° 47′ 10″	Logar.	99117 *S.*	
	Perpendicular D E, that is B H	21° 42′ 53″	Logar.	99430	
	Of the angle B C D, or B C H		Logar.	313	85° 28′ 0″ B C D
2.	Hypotenuse C B of the comet and Palilicium	21° 47′ 10″	Logar.	99117	
	Of the angle of inclination D B C	17° 32′ 39″	Logar.	119921 *A.*	
	Of the perpendicular C W		Logar.	219038	6° 25′ 0″ C W
3.	Hypotenuse C B of the comet and Palilicium	21° 47′ 10″	Mesol.	91721 + *Subt.* cossically	
	Perpendicular C W	6° 25′ 0″	Mesol.	218514 +	
	Of the angle sought, B C W		Antilog.	126793 +	73° 39′ 0″ B C W
					85° 28′ 0″ B C D
			The angle of inclination sought		11° 49′ 0″
4.	First prosthaphaeresis of inclination, C W	0° 3′ 20″	Mesol.	693899 +	
	Of the angle W C D	11° 49′ 0″	Antil.	2142 + *S.*	
	Second prosthaphaeresis of inclination, C D		Mesol.	691757 +	3′ 24″ *S.*
	The parallax reduced to the vertical was				11′ 3″
	Therefore the vertical parallax, equated a second time, is only				7′ 39″

317

[316] set as the calculation above; the parallax is printed with a leading 0, kept; the last three values are printed without a degree figure, and none is supplied.

[317] set as the calculations above, with the part figures 1.–4. at the left as printed. The marks are printed only over the first row, over 85 28 0, over 6 25 0, over 3 24 and over the closing 4; the rest are supplied in the house form; the last three values are printed without a degree figure, and none is supplied; the first prosthaphaeresis is printed with a leading 0, kept. The signs + are the page's own.

— barely 4″ smaller than the earlier, first-equated parallax; namely for December 26 at 9^h 0^m 34^s in the evening, with the comet at an altitude of 67° 26′ 0″.[318]

[Margin: Genuina parallaxis verticalis ad d. 26.Dec.] *The genuine vertical parallax for December 26.*

However well this parallax agrees with the earlier one, which was found in the preceding computation from different observations for the same altitude, let us nonetheless go further and investigate it once more for this same day, December 26, from entirely different observations, so that we may not seem to have rested content with only two examples.

Just as not each and every observation can be used for this calculation, for the various reasons given earlier, so now too we must take care not to stumble in this part as well. In turn, we shall indeed keep the same earlier observation at 9^h 0^m 34^s, as we shall also in the following investigations for this day, since we have no other at hand that could be substituted in its place; for the other, however, we shall take an entirely different one, made on December 27 at 2^h 6^m 0^s in the morning. At that time, in each of the two observations, two distances of the comet and Palilicium were indeed accurately observed with the sextant; but I think the business will not succeed so happily from these. For in these same distances the parallaxes are carried in opposite directions, and moreover Palilicium, in neither of the distances, stands precisely under one and the same vertical as the comet, nor is either distance sufficiently parallel to the horizon; so that, for that reason, the apparent motion comes out smaller than the true one. It is better, therefore, to reject these distances of the comet and Palilicium, since they are less suited to finding parallaxes, and to substitute others in their place from which the parallaxes can be derived more precisely.

[Margin: Etiamſi aliqua diſtantia obſervata,calculo non conveniat, non ideò tamen ipſa obſervatio illicò rejicienda.] *Even if some observed distance does not agree with the calculation, the observation itself is not on that account to be rejected at once.*

Yet there is no reason why, on that account, we should altogether discard those observations made at that very time, since other distances can be computed from them which will suit our purpose exceedingly well: namely, if from the longitudes and latitudes themselves (derived, that is, from those distances of the comet and Palilicium) we work out the distances of the comet and the Bright Star of Aries. For this star stood, not near the orbit, as has been the case so far, but at roughly a right angle to the orbit and the comet; so much so that in the first, eastern observation, at 9^h 0^m 34^s, the distance of the comet and the Bright Star of Aries was roughly parallel to the horizon, while in the second, later, western observation, at 2^h 6^m 0^s in the morning, it was nearly vertical. Although this configuration of the phenomenon may seem wholly foreign to that of the preceding observations, and almost the opposite of it, the parallaxes

[318] the page prints the time as 9 0° 34″, with a degree mark over the 0.

are nonetheless found from similar observations just as well, indeed even more accurately, provided the calculation is properly undertaken. How it ought to be set up correctly we shall show plainly in the following investigation. But you must give it your close attention here. For this is the first example of its kind that we are about to bring forward, one in which both the method of the equation or of the limitation and the procedure are, in many respects, altogether very different; and at the same time wholly new axioms must also be set out, both with regard to the distances (from which, that is, we are to foresee the parallaxes) and with regard to the prosthaphaereses of inclination, which in observations of this kind take on an entirely different and changing nature. Therefore, if you take delight in these subtler speculations of Urania, and are also anxious to perceive and penetrate everything properly, you certainly have reason to weigh each point more deeply and more exactly: perhaps you will not regret the labour.

[Margin: Ex contrariâ prorsùs phænomeni conſtitutione æq́; accuratè parallaxes inveſtigantur.] *From a wholly opposite configuration of the phenomenon the parallaxes are investigated just as accurately.*

[Margin: In hujusmodi operationibus diverſa planè à priori æquationis & limitationis ratio eſt adhibend.i, diverſisq́ue axiomatibus opus eſt.] *In operations of this kind a method of equation and of limitation altogether different from the earlier one must be applied, and different axioms are needed.*

First, however, let the distances be computed by the usual method, with the help of the following delineation I. In it, as you see, the arrangement of the lines is very different: for E, the Bright Star of Aries, views the comet and its orbit at nearly a right angle, and stands quite far from the orbit. Nevertheless it enjoys nearly the same triangles for unravelling the equation of the distances, as you will learn more fully from the calculation itself.

Investigation of Parallax VIII, from the Distances of the Comet and the Bright Star of Aries, for December 27 [Inveſtigatio Parallaxeos VIII. Ex diſtantiis Cometæ & Lucidæ Arietis, ad diem 27 Decemb.]

1	Observation at $9^h\ 0^m\ 34^s$ in the evening	Altitude of the comet 67° 26′	Parallax
2	Observation at $2^h\ 6^m\ 0^s$ in the morning	Altitude of the comet 31° 12′	vertical

319

[319] the words "Parall." and "Vertic." stand one above the other at the right of the two lines, so that read downward they give "vertical parallax"; no value stands beside them. The marks are printed only in the first line; the second line's are supplied in the house form.

Longitude of the comet, 1st observation	24° 35′ 30″ ♉	Latitude of the comet	13° 24′ 18″ north	Latitude of ♈	9° 57′ 30″ north
Longitude of the Bright Star of ♈	2° 49′ 57″ ♉	Complement, A I	76° 35′ 42″	Complement, A E	80° 2′ 30″
Angle I A D	21° 45′ 43″				

Logar. of the complement of the latitude of the comet, A I	2762		A I Antil.	146067	
Logar. of the angle I A D	99223 *A.*				
Logar. of the perpendicular I D	101985	21° 8′ 16″	Antil.	6965 *S.*	
			Antil.	139102	A D 75° 35′ 32″
Antilogar. D E	302		Complement of the latitude of the star, A E		80° 2′ 30″
Antilogar. I D	6965 *A.*				D E 4° 26′ 58″
Antilogar. E I	7267	21° 34′ 45″	Distance of the comet and the Bright Star of ♈, at once apparent and true.		

320

For the later distance, E L.

Longitude of the comet, 2nd observation	24° 17′ 39″ ♉		Latitude of the comet	13° 53′ 14″ north	
Longitude of the Bright Star of ♈	2° 49′ 57″ ♉		Complement, A L	76° 6′ 46″	
Angle L A K	21° 27′ 42″				

Logar. of the complement of the latitude of the comet, A L	2967		A L Antil.	142709	
Logar. of the angle L A K	100547 *A.*				
Logar. of the perpendicular L K	103514	20° 48′ 15″	Antil.	6742 *S.*	
			Antil.	135967	A K 75° 7′ 23″

[320] set unruled, in the page's own columns. The marks are printed only over the first row and over 21 8 16, 75 35 32 and 21 34 45; the rest are supplied in the house form; no figure is supplied. The sign ♈ stands for the Bright Star of Aries and the sign ♉ after the longitudes, as printed. The angle I A D is printed 21 45 43, where 24° 35′ 30″ less 2° 49′ 57″ gives 21° 45′ 33″; the figure is kept as printed. The label of the angle is printed "Augulus". The tags *A.* and *S.* are the page's own.

Antilogar. K E	369	Complement of the latitude of ♈, A E	80° 2′ 30″
Antilogar. L K	6742		K E
	A.		4° 55′ 7″
Antilogar. E L	7111	21° 21′ 10″ Apparent distance of the comet and the Bright Star of ♈.	

321

Diagram. Delineation I, an engraved figure set at the left of the text. A spherical triangle has its apex A at the top. From A a curved line, labelled along its length "Orbita Cometæ" (the orbit of the comet), runs down to the left, with a second curve close beside it. A straight side runs from A down to the right to G on the ecliptic. The large letter I stands in the open field of the triangle. Points on the left-hand curves are marked F, L and I, with M just below L; the right-hand side carries K, D and E; E is marked with a star and labelled "Luc.♈" (the Bright Star of Aries). Dotted lines run across the triangle between the two sides, and solid curves run from L and I to E. At the foot, the ecliptic ("Ecliptica.") passes through H, B, C and G; B and C stand at the feet of two near-vertical lines. "Aut. ſculps." (engraved by the author) stands below the ecliptic at the lower right.

- A (apex, top): A
- along the left curve: Orbita Cometæ (the orbit of the comet)
- field of the triangle: I (the delineation's letter)
- left curves, upper: F
- left curves, middle: L
- left curves, lower: I
- below L: M
- right side, upper: K
- right side, middle: D
- right side, lower: E, with the label Luc.♈ (the Bright Star of Aries)
- ecliptic, left: H
- ecliptic, under I and L: B, C
- ecliptic, right: G
- along the ecliptic: Ecliptica. (the ecliptic)
- lower right: Aut. ſculps. (engraved by the author)

[Margin: Si motus proprius Cometæ non adhæreret, breviori viâ res expediretur.] *If the comet had no proper motion attached to it, the matter would be settled by a shorter route.*

If, in this case, the comet had been entirely free of all proper motion, the matter would already be finished and the parallax itself found, namely from the bare difference of the distances; and that difference would need nothing

[321] set as the calculation above. The marks are printed only over the first row and over 20 48 15, 75 7 23 and 21 21 10; the rest are supplied in the house form; no figure is supplied.

but the vertical reduction and the prosthaphaeresis of inclination to elicit the genuine parallax sought. Now, however, since the comet enjoys a quite fast proper motion, the distances must first be equated with each other, as though no proper motion of the comet had intervened between the distances, so that the parallax of the orbit itself may come out; and this indeed by the fourth way, clearly set out at the beginning of this Book IV, p. 188. For by the true and apparent way (according to the first, second and third methods), with the comet in such a position, the matter is not settled so conveniently. But one must carefully consider which distance ought to be reduced, the earlier or the later, since only one of the two needs correction. In fact

[Margin: Multùm intereſt quænam diſtantia, priorne an poſterior limitanda ſit ?] *It matters a great deal which distance, the earlier or the later, is to be limited.*

however, one ought to limit the distance that is greater in itself (which also suits this operation better), the distance in which the comet, with respect to its proper motion, was truly farther from the fixed star: as in diagram I, the earlier distance I E. For there the comet at I is not only farther from the fixed star E than the comet at L, but also from F, the point of the perpendicular falling from the fixed star onto the orbit. Yet the greater distance is not always farther from F, especially if both distances happen to lie very close to the perpendicular F and the parallax lies hidden in one or the other of them; then, I say, it quite often happens that the smaller distance is in fact farther from F. This, however, can hardly be expressed without a fuller and more extended explanation (which I would gladly avoid here) as well as it can be perceived in practice itself, from a well-constructed figure and a careful investigation; nevertheless, it is very useful to know it properly, if one's intention is to determine the parallax exactly.

So that you may be all the more secure in this business, take the following axiom, but one constructed for those cases where the distances do not lie too close to F, and the perpendicular E F falls not within but outside both distances. When the comet is placed in approach to the fixed star and the perpendicular, the earlier distance (with respect to the observations), since it is the greater and makes the smaller angle with the orbit at the comet, is to be reduced and diminished with respect to the later distance: such is E I, which is the greater and shows the smaller angle E I F, for the angle E I F is smaller than the angle E L F, just as the distance E L is smaller than E I. But when the comet is in recession, from the fixed star as well as from the perpendicular, the later distance is to be limited, since in that case it is likewise the greatest and has the smaller angle.

[Margin: Axioma peculiare pro parallaxibus ad certos caſus.] *A special axiom for parallaxes, for certain cases.*

On this basis, therefore, the earlier distance E I is now to be corrected and stripped of all proper motion. Before this is undertaken, however, let the distance of the Bright Star of ♈ from the orbit, E F, be sought, as usual, and also that smaller angle F I E.

[Margin: Quænam diſtantia corrigenda.] *Which distance is to be corrected.*

For the distance of the fixed star from the orbit of the comet.

Longitude of the Bright Star of ♈		2° 49′ 57″ ♉				
Point of intersection of the orbit and the ecliptic for the 27th		28° 31′ 0″ ♉				
Difference, G H		25° 41′ 3″	An- tilogar.	10403		
Latitude of the Bright Star of ♈, E G			An- tilogar.	1518 *A.*		
Hypot. H E			An- tilogar.	11921	27° 25′ 35″ H E	
Logarith. of the hyp. H E	77522 *S.*		Log- a- rithm.	77522		
Logarith. of the side E G	175484					
Logar. of the angle G H E	97962	22° 3′ 9″ *Subt.* in this case.				
Angle of the orbit and the ecliptic		73° 57′ 0″				
There remains the angle E H F		51° 53′ 55″	Log- a- rithm.	23962 *A.*		
Of the distance E F			Log- a- rithm.	101484	21° 15′ 5″ of the Bright Star of ♈ from the orbit of the comet	

322

For the angle F I E in the right-angled triangle I F E.

Log. of the hyp. E I, distance of the comet and the Bright Star of ♈	21° 34′ 45″	100026 *S.*	
Logarithm. of the distance E F from the orbit		101484	
Logarithm. of the angle sought, F I E		1458	80° 14′ 24″

323

Now let us limit that earlier distance E I, 21° 34′ 35″, of the comet and the Bright Star of Aries, inquiring what its size was, and by how much smaller it would have been if the com- et had been entirely without any proper motion, L I. First let the perpendicular L M be computed, in the obtuse-angled triangle

[322] set unruled, in the page's own columns. The marks are printed only over the first row and over 27 25 35 and 22 3 9; the rest are supplied in the house form; no figure is supplied. No figure stands beside the latitude E G. The angle E H F is printed 51 53 55, where 73° 57′ 0″ less 22° 3′ 9″ gives 51° 53′ 51″; the figure is kept as printed. The tags *S.*, *A.* and *Subt.* are the page's own.

[323] set as the calculation above; the marks are printed in the first and last rows.

I L E, from the angle F I E found and from L I, the proper motion given by the table; then the rest, as we have taught in its place.

For the reduction and limitation of the distance E I.

Proper motion from the table	0° 48′ 55″	Log-a-rithm.	425300	L I Antilog.	10.123
Of the angle F I E	80° 14′ 24″	Log-a-rithm.	1458 *A.*		
Logar. of the perpendicular L M		Log-a-rithm.	426758 48′ 11″	Antil.	9.822 *S.*
				I M Antil.	0.301 I M 8′ 26″
Antilog. E M	7170.000			The earlier distance E I	21° 34′ 45″
Antilog. L M	9.822 *A.*			E M, in the triangle E M L	21° 26′ 19″
Antilog. L E	7179.822	sought	21° 27′ 10″ E I reduced, from which let there be subtracted		
	the later distance E L		21° 21′ 10″		
	And you will have the true parallax of the orbit		6′ 1″		

324

[Margin: An aliqua parallaxis obſervationibus ſubſit detegere.] *To detect whether some parallax underlies the observations.*

Before we go any further, however, the reasoning of this calculation advises us to pause a little, so that we may first set out certain general axioms which, unless I am mistaken, apply to any comets whatever. Under their guidance anyone will be free to judge more exactly whether or not some parallax inheres in the observations submitted to calculation; so that, if perhaps no parallax is present in them, you do not undertake and continue the calculation further in vain, but on the contrary deliberately avoid so great a labour. But it must be known in advance, as we have also impressed on you above, that in these cases (unless something prevents it), when the comet is in approach to the fixed star, the earlier distance is always greater than the other, later one; conversely, when the comet is in recession, the later is greater than the other, earlier one; and

[324] set unruled, in the page's own columns. The marks are printed only over the first row and over 48 11, 8 26 and 21 27 11; the rest are supplied in the house form; the parallax is printed "6 1" and the perpendicular and I M without a degree figure, and none is supplied. The figures 10.123, 9.822, 0.301, 7170.000 and 7179.822 are printed with a point, as here. The tags *A.* and *S.* are the page's own.

everyone will see at first glance that the matter really stands so. Yet not rarely we experience the contrary, by reason of the parallax. When, however, and in which cases this happens, no one will be able to miss, from the following 8 axioms. But I always speak (and I should like you to note this well) not of bare distances, but of those of which one or the other has already been limited, and where the proper motion has already been excluded, as was done by us a little earlier.

Axioms, by Whose Help, from Two Distances of a Comet and a Fixed Star, One of Them Corrected and the Other Bare, It Is Safely Detected Whether Some Parallax Underlies the Observations [AXIOMATA. Quorum beneficio, ex duabus Cometæ & Fixæ diſtantiis, alterâ tamen correctâ, alterâ nudâ tutò detegitur, an obſervationibus aliqua ſubſit parallaxis ?]

[Margin: Axiomata generalia notatu digna.] *General axioms worth noting.*

1. When the comet is in approach to a fixed star that is lower, that is, in the later, vertical observation, that said later vertical distance is smaller than the earlier, parallel one: especially if the comet, together with the star, is descending in respect of altitude, or is higher in the earlier, parallel observation than in the later, vertical one, and conversely lower than the fixed star in the earlier, parallel observation, if there is a parallax. But if the said later vertical distance is greater, no parallax at all is to be expected.

[Margin: Axioma primum.] *The first axiom.*

2. The same happens (namely that the later vertical distance is smaller, and the earlier parallel one greater) when the earlier observation, or distance, is vertical, and the later

[Margin: Axioma ſecundum.] *The second axiom.*

parallel, namely when the comet is in approach to a higher star in the vertical observation: especially if, in this said earlier vertical observation, the comet is lower than in the later, parallel one, and then, in this later, parallel one, higher than the fixed star, the true proper motion being moreover not very notable, if some parallax is present.

3. But when we experience the contrary, the comet being in approach to a fixed star that is higher, that is, in the later, vertical observation, that said later vertical distance can sometimes be greater than the earlier, parallel one: especially if the comet, together with the star, is in descent as regards altitude, or if in the earlier, parallel observation the comet is higher than in the later, vertical one, and then, in the earlier, parallel observation, much higher than the fixed star; and further, the proper motion is not very notable, if some parallax lies hidden.

[Margin: Axioma tertium.] *The third axiom.*

4. The same happens when the earlier observation, or distance, is vertical, and the later parallel, the comet being in approach to a lower star in the earlier, vertical observation: especially if both bodies are ascending, or the comet is lower in the earlier observation than in the later, and then the comet is lower

than the fixed star in the later, that is, the parallel, observation, and the true proper motion is not very rapid, if some parallax inheres in the observations.

[Margin: Axioma quartum.] *The fourth axiom.*

5. But when the comet is in recession from a fixed star that is higher in the later, vertical observation, the said later vertical distance is always greater than the earlier, parallel one: especially when the comet and the star are descending in respect of altitude, or when the comet is higher in the earlier, parallel observation than in the later, vertical one, and then, in the earlier, parallel observation, higher than the fixed star, if some parallax underlies them; but if the later vertical distance is smaller, there is no parallax at all.

[Margin: Axioma quintum.] *The fifth axiom.*

6. The same occurs (namely that the later, parallel distance is greater than the earlier, vertical one) when, that is, the earlier observation, or distance, is vertical, and the later parallel, the comet being in recession from a fixed star that is lower in the vertical observation: especially, however, if the comet is lower in the earlier, vertical observation and higher in the later vertical one, or both are ascending, and then the comet, in the later, parallel observation, is lower than the fixed star, if some parallax adheres to the observations.

[Margin: Axioma ſextum.] *The sixth axiom.*

7. But when the contrary happens, the comet being in recession from a fixed star that is lower, that is, in the later, vertical observation, that said later vertical distance can sometimes be smaller than the earlier, parallel one: especially if the comet, in the later, vertical observation, was much lower in altitude than in the earlier, parallel observation; much more so if the comet, in this earlier observation, is higher than the fixed star, and the true proper motion of the comet is not so swift, if a parallax resides in the observations.

[Margin: Axioma ſeptimum.] *The seventh axiom.*

8. The same occurs (namely that the later distance is smaller than that earlier, parallel one) when the earlier observation is vertical, and the later parallel, the comet being in recession from a higher fixed star: especially if the comet, in the earlier, vertical observation, was much lower in altitude than in the earlier, parallel observation, and then, in the later, parallel observation, the comet is higher than the fixed star;

[Margin: Axioma octavum.] *The eighth axiom.*

above all if the true proper motion was slow, if the observations are subject to parallaxes; otherwise they are entirely free of all parallax.

Although these axioms will perhaps seem, at first sight, of slight weight, yet in my judgement, at least, I think a great deal should be attributed to them: not so much because it took art and labour to construct them properly, as because they have a great use with regard to phenomena of every kind; and because, with their help, it is at once clear to anyone whether or not some parallax inheres in the corrected distances, something which otherwise, believe me, would give a great deal of trouble even to those not lightly versed in the science of the stars. Above all, these axioms will be of no small help to those more extended and

most intricate ones handed down earlier, on p. 179, and will shed a remarkable light on them; and the matter will become all the clearer: namely, why the apparent motion is sometimes carried in the contrary direction, although a parallax is present in the observations. Then, too, these will leave you free to distinguish properly between observations and distances, whether observed or computed, and to choose the more certain and more suitable ones; and also to avoid without difficulty those above all in which the apparent motion is driven in the contrary direction, according to axioms 3, 4, 7 and 8. This is not, indeed, for the reason that no parallaxes at all can be drawn from them; but only because from them, sometimes, parallaxes cannot be elicited as accurately, to within a few seconds, indeed even to within one whole minute or two, according to their size, as we can elicit them from those that follow axioms 1, 2, 5 and 6 (in which the apparent motion is always found to be ordered).

[Margin: Axiomata præcedentia, ſicut haud vulgari labore ſunt conſtructa, ſic pariter egregium habent uſum.] *The preceding axioms, just as they were constructed with no ordinary labour, so likewise have an excellent use.*

However much we wished it, we could not always use these ordered distances for drawing out the parallaxes; sometimes, where the others were lacking, we had to rely on those unordered observations as well. Nevertheless, as we have said, hardly any very notable small difference then showed itself. Yet we always attributed more to the ordered ones, as is indeed deservedly their due, and for the most part used those unordered ones only as a supplement.

[Margin: Ordinatis diſtantiis, quando fieri poteſt, inſiſtendum.] *One should rely on ordered distances when it can be done.*

But I return to our calculation, in which the difference of the distances, one of them, that is, corrected and the other bare, came out as 6′ 1″, which now represents the parallax of the orbit. For since, according to our axiom 1, the later vertical distance is smaller than the earlier, parallel distance, a parallax certainly inheres in those distances; and so the calculation must by all means be continued, so that we can derive the genuine vertical parallax, equated a second time. We shall obtain it, moreover, extremely well from this configuration with respect to the Bright Star of Aries, according to the first axiom, and somewhat better than from the following calculation IX, according to axiom 3, for the reasons already stated: there the comet's position with respect to Capella was quite different, although for the same time.

[Margin: Adjecto calculo parallaxis inhæret.] *A parallax inheres in the calculation added.*

This parallax of the orbit, then, found to be 6′ 1″, must now also be reduced to the vertical; and indeed from the later, western observation, since there the comet stood almost under the same vertical as the fixed star; so that in this way the prosthaphaeresis of inclination may afterwards be investigated from the earlier, parallel observation. The prosthaphaeresis of inclination could, however, also have been traced first from the earlier observation and afterwards

reduced to the vertical, provided you note carefully which observation pertains to the vertical reduction;

[Margin: Quo ordine inveſtigatio inſtituenda.] *In what order the investigation is to be undertaken.*

meanwhile, however, since in the preceding examples we have always been accustomed to bring the parallaxes back to the vertical first, let us follow that order further.

This vertical reduction, however, in those examples, namely, in which the fixed stars are set at a right angle to the comet and its orbit (as in this configuration of the Bright Star of Aries, or in the following one of Capella and the comet), is carried out in an entirely different way than if the fixed stars are situated near the orbit itself, that is, at a smaller angle: something that is truly most necessary to observe; otherwise you will go badly astray. For in these cases the parallax is not deduced from the apparent and the true motion, nor estimated in the orbit; it is investigated only from the distances stripped of all proper motion, just as if no proper motion had belonged to the comet. And the matter is taken as if, in one observation, the comet, together with the fixed star, had been parallel to the horizon, where the distance is at once true and apparent; and in the other, as if the comet, together with the star, had stood under about the same vertical, where the parallax necessarily shows itself at once, when, that is, one distance is subtracted from the other. Here, therefore, the parallax is considered in the line of distance E C (Fig. K, following), and by no means in the orbit, as it must be with those fixed stars lying near the orbit.

[Margin: Nota; Quandò Fixæ adCometam ſub normali angulo exiſtunt, reductio ad verticalem aliâ planè viâ tentanda eſt.] *Note: when the fixed stars stand at a right angle to the comet, the reduction to the vertical must be attempted in an entirely different way.*

[Margin: Quænam hujus rei ſit ratio ?] *What the reason for this is.*

But it very rarely happens that the comet C and the fixed star E, or the line of distance E C, stand so exactly under the same vertical, that is, that the distance E C faces the horizon at an exact right angle; usually, as also in this example of ours adjoined, the line of distance of the comet and the fixed star, C E, inclines to the horizon at a certain acute angle. Therefore, since the parallax found for the orbit, or rather the mean parallax, 6′ 1″, is given in this line of distance C E, inclined to the horizon, it certainly follows that this parallax partakes in part of the parallax of longitude and of latitude, and that in the vertical line C D it must necessarily have been somewhat greater. It falls to us now to examine this difference, which arises from the angle of the distance and the vertical, E C D: namely, how great the parallax itself would have appeared in the vertical circle A C D O.

Now let us say in what way this reduction to the vertical is accomplished, namely by seeking the angle E C D in place of that of the vertical and the orbit used for stars near the orbit. 1. For that time of the observation, $2^{h}\ 6^{m}\ 0^{s}$, let both the altitudes and the azimuths of both the comet and the fixed

star be sought, if they are not given by the observation; then the difference of the azimuths, if the comet and the fixed star lie in the same quadrant, or, if not, the complement of each one's azimuth to the quadrant, gives K O, or the angle E A D. 2. In the right-angled triangle E D A, let the perpendicular E D be found from the angle A just found and from A E, the complement of the altitude of the fixed star. 3. In the triangle E D C, right-angled at D, from the perpendicular E D found and the hypotenuse E C, namely the distance of the comet and the fixed star, the angle sought, E C D, becomes known. 4. Transfer the parallax of the orbit found above, 6′ 1 [?], C G, into the line of distance C E, and construct the right-angled triangle C G I, so that C I is the hypotenuse, in the vertical circle A C O; and at the same time you will have from that C I the parallax reduced to the vertical that is sought, which you will find from the angle G C I, or E C D, and from C G, the parallax of the orbit.

[Margin: Quâ ratione parallaxis mixta, ad nudam verticalem redigi debeat.] *In what way a mixed parallax should be reduced to the bare vertical.*

Diagram. Figure K, the left of two engraved circular figures standing side by side at the head of the page, for the observation at $2^{h}\ 6^{m}\ 0^{s}$ in the morning. A circle stands for the sky, with the zenith A at the top and the horizon M L crossing it as a shallow arc. The ecliptic and the equator run as two parallel diagonals down from the upper left. The comet C, drawn as a small circle with a cross, lies on the arc of the comet's path, which runs from C to R on the rim; the star E, the Bright Star of Aries, lies below and to the right of C. Dotted lines run from C towards F, from I towards G, and from D through E towards V. O and K stand on the horizon below D and E, Y on the horizon at the left; the orbit runs up from X at the lower left; N stands on the rim at the bottom.

- A (top of the circle): zenith
- F, S (upper rim, right of A)
- [?] (outside the circle at the upper left, near the end of the ecliptic): a script sign, not identified
- P (left rim, upper)
- "Ecliptica." (diagonal, upper left): the ecliptic
- "Æquator." (diagonal, parallel to it): the equator
- C (centre, upper): the comet
- "Cometæ." (along the arc from C to R): of the comet
- R, V (right rim)
- G, I, D (between C and the horizon)
- E (star, right of D): with "Lucid. ♈", the Bright Star of Aries
- M, L (ends of the horizon); "Horizon." along it: the horizon
- Y, O, K (on the horizon)
- "Orbita" (lower left, rising from X): the orbit
- X (lower left rim)
- "Occidens." (lower field): west
- K (large, lower field): the figure's letter
- N (bottom rim)

• "Hor. 2 6′ 0″ m." (below the circle): at 2^h 6^m 0^s in the morning

Diagram. Figure L, the right of the two engraved figures, for the observation at 9^h 0^m 34^s in the evening. A circle with the zenith A at the top; the vertical A O runs down through the comet C, drawn as a small circle with a cross, and through H and D below it. The star B, the Bright Star of Aries, lies to the right of D, with E just above it; dotted lines run from C and H towards B and from B up towards V. The ecliptic runs on an arc from the left rim; the equator and the horizon run on two arcs from M to L; the orbit of the comet runs up from X at the bottom. "Autor ſculpſit" (the author engraved it) stands at the lower right of the plate.

• A (top of the circle): zenith
• S, V (upper rim, right of A)
• C (on the vertical): the comet
• H, D (below C on the vertical); W (beside D)
• E (just above B)
• B (star): with "Lucid. ♈", the Bright Star of Aries
• "Ecliptica." (arc from the left rim): the ecliptic
• [?] (outside the circle at the left rim): a script sign of the same form as in figure K, not identified
• M, L (ends of the horizon)
• "Æquator." (upper arc from M to L): the equator
• "Horizon." (lower arc from M to L): the horizon
• O, K (on the horizon)
• "Orbita Cometæ" (rising from X): the orbit of the comet
• "Meridies." (lower field): south
• L (large, lower field): the figure's letter
• X (bottom rim)
• "Hor. 9 0′ 34″. v." (below the circle): at 9^h 0^m 34^s in the evening
• "Autor ſculpſit" (lower right of the plate): the author engraved it

For the altitude of the Bright Star of Aries, at 2^h 6^m 0^s in the morning. — For the altitude of the comet, at 2^h 6^m 0^s.

Right ascension of the Sun	276° 37′ 43″			276° 37′ 43″		
Elong. from the meridian	211° 30′ 0″ *A.*			211° 30′ 0″ *A.*		
Right ascension of the midheaven	128° 7′ 43″	360° cast off		128° 7′ 43″		
Right ascension of the Bright Star of ♈	26° 57′ 0″	Right ascension of the comet		47° 54′ 24″		
Distance from the meridian	78° 49′ 17″	Complement to 180, Log.	1915	80° 13′ 19″	Logarith.	1464
Declination of the Bright Star of ♈	21° 49′ 0″	Antilog	7432 *A.*	32° 18′ 30″	Antilog.	16820 *A.*

	65° 36′ 45″		perp. E V, Log.	9347	56° 23′ 57″	Logarith.	18284 C F
			Log. of the declination C V	62646			
Logar. of the declination E T	98983		Antilogar. C F	59165			
Antil. of the perp. E V	88454 *S.*		Antilogar. S F	3481	15° 1′ 52″ *S.* in this place		
Antilog. V S	10529	25° 50′ 0″	Compl. of the elev. of the pole S A		35° 37′ 0″		
Compl. of the elevat. of the pole		S A 35° 37′ 0″	Antilogar. A F	6598	20° 35′ 8″		
Antilog. V A	73830	V A 61° 27′ 0″	Antilogar.	59165			
Antilog. V E	88454		Logarithm.	65763	31° 12′ 13″	Altit. of the comet, C O	
Logarith. E K	162284	11° 22′ 59″	altitude of the Bright Star of Aries				

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[Margin: Altitudines Lucid. Arietis & Cometæ ad hor. 2 6 min.] *Altitudes of the Bright Star of Aries and of the comet at 2^h 6^m.*

For the azimuth. — For the azimuth.

			Log. of the dist. from M.	1464		
Logar. of the perp. E V	9347		Antil. of the declin.	16820 *A.*		
Antil. of the altitude	1986 *S.*		Logarithm.	18284		
Log. of the azim. of ♈	7361	68° 17′ 5″ *Occid. Sept.*	Antil. of the altit. of the comet	15627 *S.*		
Azimuth of the comet		76° 51′ 0″ *Occid. Sept.*	Log. of the azimuth	2657	76° 51′ *Occid. Sept.*	
K O, or the angle E A C		8° 34′ 0″ Logar. 190408				
Compl. of the altit. of the Bright Star of ♈		78° 37′ 7″ Logar. 1986 *A.*				

[325] set unruled, in the page's own columns; the two calculations stand side by side, the star's at the left and the comet's at the right, the star's logarithms of the rows "Distance from the meridian" to the row beginning 65 36 45 standing in the middle columns, and the comet's calculation continuing in the middle and right columns. The marks are printed only over the time and over the first row of each calculation, and as two free-standing rows of marks over 15 1 52 and over 25 50 0; the rest are supplied in the house form; no figure is supplied. "C O" is printed below "Altit. Com." at the line end. The tags *A.* and *S.* are the page's own.

Perpendicular E D		Logar. 192394		
Distance of the comet and ♈, later	21° 21′ 10″	Logar. 101030 *S.*		
		Logar. 91364	23° 38′ 41″	Angle sought, E C D

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For the reduction to the vertical.

Mesolog. of the side C G, the fictitious parallax	0° 6′ 1″	634804	
Antilog. of the angle E C D	23° 38′ 41″	8768 *S.*	
Mesol. of the parallax reduced to the vertical		626036	6′ 34″

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Even with the vertical parallax found in this way, however, we must not yet rest content with it as if it were the mean parallax; we must go on to investigate the prosthaphaereses of inclination, worked out from the earlier observation at $9^h\ 0^m\ 34^s$. These are indeed found by the same method shown above; but they are applied to the parallax of the orbit in an entirely different, indeed almost contrary, way than if the fixed star had lain either under the orbit itself or near it. For with those fixed stars removed at a right angle from the comet and its orbit, the proper motion is not taken into account; instead the matter is settled from the distances, according as the earlier or the later was greater or smaller. It is therefore extremely difficult, in any case where the fixed stars lie at a right angle towards the comet and its orbit, to grasp correctly whether the prosthaphaereses ought to be added or rather subtracted. We did indeed give certain rules for this purpose on p. 194, from which this very thing can be sought; but those can be extended only to the cases where the fixed star stands either under the comet's orbit itself or very near it, and where the apparent and true proper motion is considered. But since here the parallaxes are deduced entirely from the distances, and the fixed star stands at a right angle to the comet

[326] set unruled, in the page's own columns; the comet's azimuth calculation stands at the right in its first five rows. The marks are printed only over 76 51 at the right and over 23 38 41; the rest are supplied in the house form. "Sept." of the right-hand result is printed below "Occid.", at the line end of the next row. The angle K O is printed "8 34 0", where 76 51 0 less 68 17 5 gives 8° 33′ 55″; the complement of the star's altitude is printed "78 37 7", where 90° less 11° 22′ 59″ gives 78° 37′ 1″; both are kept as printed. The page names the angle here "E A C", where the text on the facing page names it "E A D"; kept as printed. The tags *A.* and *S.* and the direction tag *Occid. Sept.* are the page's own.

[327] set as the calculations above; the marks are printed over the first row and over 6 34; the result is printed without a degree figure, and none is supplied.

and its orbit, the prosthaphaereses, as I have just touched on, take on an almost contrary title, as the following axioms will make quite clear. They are divided into two classes. The first reveals the characters of the prosthaphaereses when the earlier observation, or distance, is parallel to the horizon, and the other, the later, is vertical; the second, when the earlier observation, or distance, is vertical, and the later parallel to the horizon. Just as these configurations of the comet with respect to the fixed star are most different from each other, so too the prosthaphaereses there obtain an entirely contrary effect.

[Margin: In hocce exemplo proſthaphæreſes inclinationis contrariâ planè ratione orbitæ parallaxi applicantur.] *In this example the prosthaphaereses of inclination are applied to the parallax of the orbit in an entirely contrary way.*

[Margin: Ardua res eſt, Fixis ad angulum rectum ratione Cometæ conſtitutis, affectiones proſthaphæreſium ritè dignoſcere.] *It is a hard matter, when the fixed stars are set at a right angle with respect to the comet, to discern the characters of the prosthaphaereses correctly.*

[Margin: Axiomata ab Autore traduntur pro titulis proſthaphæreſium, quæ in duas claſſes referuntur.] *Axioms are given by the author for the titles of the prosthaphaereses, which are arranged in two classes.*

Axioms [AXIOMATA.]

Of what character, that is, the prosthaphaereses are, of both the first and the second equation, when the earlier distance is parallel and the later vertical: that is, for those fixed stars standing at about a right angle with respect to the comet and its path. [Cujusnam nempè ſint affectionis, Proſthaphæreſes, tam primæ, quàm ſecundæ æquationis; exiſtente priore diſtantiâ parallelâ, poſteriore verò verticali : in iis nempè Fixis ſub normali circiter angulo, reſpectu Cometæ, ejusq́; viæ, exiſtentibus.]

[Margin: Prior claſſis.] *The first class.*

1. When the comet is above the fixed star and its perpendicular, in approach, the prosthaphaeresis is added to the parallax reduced to the vertical, so that the genuine equated vertical parallax results. But if the comet lies below the perpendicular so often mentioned above, B E, drawn in the figure on p. 176, or, in figure H above, the perpendicular B H, even though it seems to be above the fixed star, the prosthaphaeresis is Subtracted.
2. When the comet is below the fixed star, in approach, the prosthaphaeresis of inclination is subtracted.
3. When the comet is above the fixed star and its perpendicular, in recession, the prosthaphaeresis is subtracted; but if it lies below the perpendicular, even though it seems to be above the fixed star, the prosthaphaeresis is Added.
4. When the comet stands below the fixed star, in recession, the prosthaphaeresis is Added.

Axioms [AXIOMATA.]

When the earlier distance is given as vertical, and the later as parallel. [Datâ priore diſtantiâ verticali, & poſteriore parallelâ.]

[Margin: Poſterior claſſis] *The second class.*

5. When the comet is above the fixed star and its perpendicular, in approach, the prosthaphaeresis is Subtracted; but it is added if the comet is below the perpendicular, even though it lies above the fixed star.
6. When the comet is below the fixed star, in approach, the prosthaphaeresis of inclination is Added.
7. When the comet is above the fixed star and the perpendicular, in recession, the prosthaphaeresis is Added; but it is Subtracted if the comet is below the perpendicular, even though it stands above the fixed star.
8. When the comet lies below the fixed star, in recession, the prosthaphaeresis of inclination is Subtracted.

Although these axioms may seem extremely brief, they are nevertheless in truth very well founded, even though they are hardly easy for everyone to grasp at first sight, because they appear almost to conflict with the earlier ones. But whoever weighs this matter more exactly, with the aid of a globe and a well-constructed diagram, and also of the preceding axioms on distances given on p. 226, will readily admit that everything is entirely so. For example: in figure I above, and in the earlier observation, with the comet above the fixed star and in approach to it towards F, the earlier distance was given as greater than the later, according to the first axiom above, p. 226. But since the earlier, greater distance is somewhat diminished by reason of the parallax depressing the comet towards H, the difference of these distances (or the parallax), of which, that is, the greater has become a little diminished, becomes smaller by as much as that prosthaphaeresis of inclination C D requires; and therefore that prosthaphaeresis must necessarily be Added, just as our first axiom of the prosthaphaeresis also requires. You will be able to examine all the remaining cases in the same way, provided you first recognise correctly whether the comet lies in approach or rather in recession, and whether above or rather below the fixed star. You will find, however, that it is a matter of still deeper inquiry to judge correctly of what character the prosthaphaereses are, especially if the fixed star stands, in each distance, at an exactly right angle.

[Margin: Hæc axiomata ſolido nituntur fundamento,ut ut ſuperioribus quaſi adverſari videantur.] *These axioms rest on a solid foundation, even though they seem, as it were, to oppose the earlier ones.*

Now let us come to the calculation of the prosthaphaeresis itself, seeking first the altitude of the Bright Star of Aries for the earlier observation, with the aid of the preceding diagram L, in which the comet, in turn, is higher than the fixed star and, as is clear from figure I, lies in approach to it, or to the perpendicular E F. Therefore, according to the first axiom of the first class, just given, the prosthaphaeresis of both the first and the second equation is Additive, for the reason shown a little earlier.

[Margin: Sequitur Calculus.] *The calculation follows.*

For finding the altitude of the Bright Star of Aries at 9^h 0^m 34^s in the evening.

Right ascension of the Sun	276° 23′ 48″		
Elong. from the meridian	135° 8′ 30″		
Right ascension of the midheaven	51° 32′ 18″	360° cast off	
Right ascension of the Bright Star of ♈	26° 57′ 0″		
Distance from the meridian	24° 35′ 18″	Logar.	87683
Declination of the Bright Star of ♈	21° 49′ 0″	Antilog.	7432 *A.*
		Logar.	95115 B V 22° 43′ 27″ in diagram L

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Logar. of the declination	98983				
Antilog. B V	8080 *S.*		Antilog.	8080	
Antilog.	90903	66° 15′ 38″			
Compl. of the elev. of the pole		35° 37′ 0″ *S.*			
V A		30° 38′ 38″	Antilog.	15040 *A.*	
			Antil. A B, or Logarithm. B K	23120	52° 31′ 15″ Alt. of the Bright Star of ♈
Logar. B V	95115				67° 26′ 0″ Alt. of the comet
Antil. of the altit. of the star	49665 *S.*		Difference of the altit. of the comet and the star		14° 54′ 45″
Logar. of the azimuth	45450	39° 24′ 8″	Azimuth, *Occid. Mer.*, of the Bright Star of ♈		

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[Margin: Azimuth Lucidæ Arietis.] *Azimuth of the Bright Star of Aries.*

For the angle B A C.

[328] set unruled, in the page's own columns. The marks are printed only over the first row and in the last; the rest are supplied in the house form; no figure is supplied. The last row is set at the right, under the logarithm column. The tag *A.* is the page's own.

[329] set unruled, in the page's own columns; the calculation continues that of the previous page. The marks are printed only over 66 15 38 and 52 31 15, and in the last row; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the direction tag *Occid. Mer.* are the page's own.

Compl. of the altit. of the comet	C A	22° 34′ 0″	Log.	95774	
Compl. of the altit. of the Bright Star of ♈	B A	37° 28′ 45″	Log.	49682 *A.*	
Difference		14° 54′ 45″	Log.	145456	Earlier aggregate
Dist. of the comet and the Bright Star of ♈	B C	21° 34′ 45″			
Sum		36° 29′ 30″			
Half		18° 14′ 45″	Logar.	116123	
Difference		6° 40′ 0″			
Half		3° 20′ 0″	Logar.	284482 *A.*	
			Later aggregate	400605	
			Earlier aggregate	145456 *S.*	
				255149	
			Logar.	127574	16° 12′ 49″ Half-angle
Angle B A C sought					32° 52′ 38″

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This same angle is also found in an entirely different way, namely when the azimuths of the comet and the fixed star are given. For the difference of the azimuths, if they are found in the same quadrant, or, if in different ones, the sum of the complements of the azimuths to the quadrant, constitutes the angle sought, B A C.

Azimuth of the comet	6° 58′ 35″	*Occid. Merid.*
Azimuth of the Bright Star of ♈	39° 24′ 8″	*Occid. Merid.*
Angle sought, B A C	32° 25′ 33″	quite the same magnit. as above

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Inquiry into the angles A B C, A B D and C B D, the parallactic angle of inclination, namely of the first equation.

Angle	B A C	32° 25′ 38″	Logarithm.	62319

330 set as above; the marks are printed only over 22 34 0 and 16 12 49; the rest are supplied in the house form. The angle sought is printed 32 52 38 [recte: 32° 25′ 38″]: twice the half-angle 16° 12′ 49″ gives 32° 25′ 38″, and the page itself carries that value for the angle B A C in the inquiry below.

331 set as above; the marks are printed only over the first row; the rest are supplied in the house form. The direction tag *Occid. Merid.* is the page's own.

Compl. of the alt. of the comet	A C	22° 34′ 0″	Logarithm.	95774 *A.*		
			Logarithm.	158093		
Side 3, dist. of the comet and the star	B C	21° 34′ 45″	Logarithm.	100026 *S.*		
Angle sought	A B C		Logarithm.	58067	34° 1′ 23″	A B C
Angle	B A C	32° 25′ 38″	Logarithm.	62319		
Compl. of the alt. of the star	A D	37° 28′ 45″	Logarithm.	49682 *A.*		
			Logarithm.	112001	19° 2′ 34″	D E Perpend.
Compl. of the alt. of the Bright Star of ♈	A D	37° 28′ 45″	Antilogar.	23122		
Perpendic.	D E	19° 2′ 34″	Antilogar.	5628 *S.*		
	A E		Antilogar.	17494	32° 54′ 43″	A E
					37° 28′ 45″	A B
Side	E B	4° 34′ 2″	Logarithm.	253038 +· *S.Cosf.*	4° 34′ 2″	E B
Perpend.	D E	19° 2′ 34″	Mesologar	106373 +		
Angle	D B A		Mesologar	146665 —	77° 0′ 34″	D B A
					34° 1′ 23″	A B C
Angle of inclination sought					42° 59′ 11″	D B C

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For the prosthaphaeresis of the first equation, to be Added.

Parall. reduced to the vertical	B C	0° 6′ 34″	Logarithm.	626036		
Angle of inclination	D B C	42° 59′ 11″	Logarithm.	38282 *A.*		
				664318	4′ 28″	*Add.*
The parallax reduced to the vertical was					6′ 34″	
The vertical parallax, first equated					11′ 2″	

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[332] set unruled, in the page's own columns; the marks are printed only over 32 25 38 of the first row and over 34 1 23 of the fifth; the rest are supplied in the house form; no figure is supplied. The signs + and — and the tags *A.*, *S.* and *S.Cosf.* are the page's own.

[333] set unruled, in the page's own columns; the marks are printed over 0 6 34 and in 4 28; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *Add.* are the page's own.

[Margin: Parallaxis primò coæquata.] *The parallax first equated.*

For finding the prosthaphaeresis of the second equation, B D, here likewise to be Added.

1.	Hyp. C B, dist. of the comet and the Bright Star of ♈		21° 34′ 45″	Logar.	100026 *S.*			
	Perpend. D E, that is, B H		19° 2′ 34″	Logar.	112001			
	Angle B C D, or B C H			Logar.	11975		62° 31′ 0″	B C D
2.	Hyp. C B, dist. of the comet and the Bright Star of ♈		21° 34′ 45″	Logar.	100026			
	Angle of inclination	D B C	42° 59′ 11″	Logar.	38282 *A.*			
	Perpendicular	C W		Logar.	138308		14° 31′ 0″	C W
3.	Hyp. C B, dist. of the comet and the Bright Star of ♈		21° 34′ 45″	Mesol.	92737	+ *Subt. Cosf.*		
	Perpendic.	C W	14° 31′ 0″	Mesol.	135120	+		
				Antilog.	42383	+	49° 7′ 0″	B C W
							62° 31′ 0″	B C D
	Angle of inclination of the second equation						13° 24′ 0″	W C D
4.	Prosth. of inclin. of the first equat.	C W	0° 4′ 28″	Mesol.	664318	+		
	Angle	W C D	13° 24′ 0″	Antil.	2760	+ *S.*		
	Prosth. of inclinat. of the second equat.	C D		Mesol.	661558	+	4′ 36″	*A.*
	Parallax reduced to the vertical						6′ 34″	

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Therefore the genuine vertical parallax, equated a second time, is 11′ 10″, namely for December 27 at 2^h 6^m 0^s in the morning, when the comet was at an altitude of 31° 12′ 13″.

But you may ask why this parallax does not belong to the altitude 67° 26′ 0″, that is, to the earlier observation, as happened in the earlier observations, especially in the preceding one, made from the same observations. I shall say: because there the earlier distance was always vertical and the later parallel to the horizon, whereas in this calculation the earlier distance was parallel to the horizon and the later almost vertical; and hence the parallax too belongs to

[334] set unruled, in the page's own columns, the step figures 1. to 4. standing at the head of their first rows; the marks are printed over 21 34 45 of step 1, over 62 31 0 and 14 31 0, and in 4 36; the rest are supplied in the house form; no figure is supplied. The signs + and the tags *A.*, *S.* and *Subt. Cosf.* are the page's own.

the later, vertical observation, namely to the altitude 31° 12′ 13″ — something I would like you to note well.

[Margin: Cui altitudini parallaxis modò inventa competat.] *To which altitude the parallax just found belongs.*

However, for the sake of greater certainty, let us seek this same parallax again, for the same altitude and from the same observations, but from different distances, namely those of the comet and Capella, which held an entirely different position with respect to the comet. Capella, it is true, likewise lay at about a right angle to the comet and its orbit, and in the first observation the distance was parallel to the horizon, while the other distance, in the second observation, was vertical. But in this second, vertical observation, at 2^{h} 6″ 0″ [recte: 2^{h} 6^{m} 0^{s}] in the morning, the Bright Star of Aries stood below the comet and Capella above it: a most different and entirely contrary configuration. So the parallax has also vitiated the distances in an entirely contrary way. Moreover, in the earlier, vertical distance, the Bright Star of Aries was below the comet, with respect to it, while Capella in the same earlier observation lay above it. Hence, in turn, in this following example the prosthaphaeresis of inclination will be subtractive, according to axiom 2, just as in the preceding example, with the Bright Star of Aries, it had been Additive, according to axiom 1.

[Margin: Ex diverſis nunc diſtantiis, parallaxis ad eandem altitudinem quæratur.] *Let the parallax for the same altitude now be sought from different distances.*

So much so that these cases are entirely conflicting and contrary to each other; and therefore both the method of our calculation and the parallax itself will become clear all the more certainly, namely whether it agrees with the earlier one or rather exceeds it. For if our calculation is liable to even the smallest error, that defect must show itself here; but if not, you can be all the more secure about these parallaxes of ours, both those already computed and those still to be computed.

Investigation of Parallax IX, from the Distances of the Comet and Capella, Computed, for December 27, Morning [Inveſtigatio Parallaxeos IX. Ex diſtantiis Cometæ & Capellæ ſupputatis, ad diem 27 Decemb. matut.]

For the earlier distance, E I.

1	Observation at 9^{h} 0^{m} 34^{s} in the evening	Altitude of the comet	67° 26′ 0″	*Orient.*
2	Observation at 2^{h} 6^{m} 0^{s} in the morning	Altitude of the comet	31° 12′ 13″	*Occid.*

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[335] the time marks are printed only over the minutes and seconds of the first time, with no hour mark, and the angle marks only over the first altitude; the rest are supplied in the house form. The direction tags *Orient.* and *Occid.* are the page's own.

Longitude of the comet, B, 1st observ.	24° 35′ 30″ ♉	Latitude of the comet, B I	13° 24′ 18″ north	Latitude of Capella, G E	22° 52′ 15″ north
Longitude of Capella, G	17° 0′ 12″ ♊	Complement, A I	76° 35′ 42″	Complement, A E	67° 7′ 45″
Angle E A D	22° 24′ 42″				

Logar. of the complement of the latitude of Capella, A E	8188	67° 7′ 45″	Antil.	94509	
Logar. of the angle E A D	96427 *A.*				
Logar. of the perpendicular E D	104615	20° 33′ 57″	Antil.	6586 *S.*	
			Antil.	87923	A D 65° 28′ 26″
Antilogar. D I	1896				A I 76° 35′ 42″
Antilogar. D E	6586 *A.*				D I 11° 7′ 16″
Antil. of the distance E I	8482	23° 16′ 0″	Earlier distance of the comet and Capella.		

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[Margin: Diſtantia Cometæ & Capellæ.] *Distance of the comet and Capella.*
For the later distance, E L.

Longitude of the comet, C, later observ.	24° 17′ 39″ ♉	Latitude of the comet, L I	13° 53′ 14″
Longitude of Capella, G	17° 0′ 12″ ♊	Its complement, A L	76° 6′ 46″
Differ. C G, or angle E A K	22° 42′ 33″		

Log. of the complement of the latitude of Capella, E A	8188	67° 7′ 45″	Antil.	94509	
Logar. of the angle E A K	95176 *A.*				
Logar. of the perpend. E K	103364	20° 50′ 13″	Antil.	6764 *S.*	
			Antil.	87745	A K 65° 25′ 36″

336 set unruled, in the page's own columns. The marks are printed only over the first row of each group and over 67 7 45 and 65 28 26; the rest are supplied in the house form; no figure is supplied. The signs ♉ and ♊ stand after the longitudes, as printed. The tags *A.* and *S.* are the page's own.

Antilogar. K L	1749		A L 76° 6′ 46″
Antilogar. of the perp. E K	6764 *A.*		K L 10° 41′ 10″
Antilogar. of the dist. E L	8513	23° 18′ 30″Distance of the comet and Capell., E L.	

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Since, then, it is still unknown whether Capella stood exactly at a right angle to the comet and its orbit or not, and likewise whether its proper motion between the two observations was slow or rather fast, we must first examine the distance of Capella from the orbit, and also the angle F I E, as being smaller than the other angle, F L E, in the following Figure M, so that the earlier distance E I may likewise be bounded with respect to E L and the proper motion entirely eliminated. But, you will say, why should E I be corrected here, as the smaller distance found, and not the larger, E L, as was taught above on p. 225? I admit, indeed, that I said the larger distance must always be corrected; but I remember that I also added: larger in itself. For although E L came out larger from the calculation, it was in fact smaller, and was somewhat larger only by reason of the parallax. For the comet was both in recession and, in the later observation, stood with the fixed star under the same verti- cal; there, since it was placed below the fixed star, it was depressed toward the horizon by the parallax, and consequently that distance E L was made a little smaller, as is clearly evident from diagram N. Therefore the earlier distance E I, as larger in itself, must now be limited in the usual way, according to that axiom on p. 225.

For the distance of Capella from the orbit, the angle F I E, and the limitation of the distance E I.

1	Longitude of Capella		17° 0′ 12″ ♊			
	Point of intersect. for the 26th		28° 31′ 0″ ♉			
	Difference, G H		18° 29′ 12″	Antilogar.	5298	
	Latitude of Capella, E G		22° 52′ 15″	Antilogar.	8188 *A.*	
				Antilogar.	13486	29° 5′ 30″ E H
	Logar. of H E, hyp.	72111 *S.*		Logarithm.	72111	H E
	Logar. of E G, latit.	94505				
	Logar. of the angle G H E	22394	53° 4′ 7″			

337set as above. The marks are printed only over the first row and over 67 7 45 and 65 25 36; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own.

	Angle of the orbit and the ecliptic, compl.	106° 3′ 0″ F H G			
	There remains the angle E H F	52° 58′ 53″	Logar.	22508 *A.*	
			Logar.	94619	E F 22° 50′ 37″, dist. of Capella from the orbit
2	Log. of the hyp. E I, of the earlier dist.	23° 16′ 0″		92884 *S.*	
	Log. of the dist. from the orbit, E F	22° 50′ 37″		94619	
	Log. of the angle F I E			1735	79° 21′ 30″
3	Log. of the proper motion from the table	48′ 55″ L I		425300	L I Antil. 10.123
	Log. of the angle F I E	79° 21′ 30″		1735 *A.*	
	Log. of the perp. L M			427035	48′ 3″ Antil. 9.768 *S.*
					I M Antil. 0.355 9′ 10″
	Antil. E M	8367.000	Dist. E I of Capella and the comet		23° 16′ 0″
	Antil. L M	9.768	Side E M in the triang. E M L		23° 6′ 50″
	Antil. E L	8376.768	sought, E I, the reduced earlier distance		23° 7′ 35″
			But the later distance E L was found to be		23° 18′ 30″
			The difference, therefore, is the true parallax of the orbit		10′ 55″

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[Margin: Parallaxis Orbitæ.] *Parallax of the orbit.*

Although the later distance E L is here larger than the earlier one, I E, and the comet is approaching the fixed star, there is nevertheless parallax in these observations, according to our axiom 3, p. 227. Therefore the calculation must be continued, and this parallax must be brought back to the vertical by exactly the method used in the preceding calculation, except that the perpendicular D E in diagram N is computed from the complement of the altitude of the

338 set unruled, in the page's own columns, the part figures 1 to 3 standing at the head of their first rows. The logarithms of parts 2 and 3 stand to the right of their arcs, set here in the second logarithm column. The label "Dist. of Capella from the orbit" stands in two lines at the right of the eleventh and twelfth rows. The marks are printed over 17 0 12, 29 5 30, 53 4 7, 23 16 0 of part 2, 79 21 30 of part 2, 48 55, 48 3, 9 10 and 23 7 35; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 48 55, 48 3, 9 10 or 10 55. The signs ☊ and ☋ and the tags *A.* and *S.* are the page's own.

fixed star (because the comet is lower than the fixed star), and not from the complement of the altitude of the comet, as is indeed required when the comet is higher than the fixed star. In this way the reduction is always made to the comet's vertical circle, A D C O.

For the altitude of Capella at 2^h 6^m 0^s in the morning, the angle E C D, and the reduction to the vertical.

Right asc. of the midheaven, from the earlier calc.	128° 7′ 43″						
Right asc. of Capella	72° 46′ 0″ *S.*						
Distance from the meridian	55° 21′ 43″	Logar.	19512				
Declin. of Capella	45° 35′ 30″	Antil.	35701 *A.*			Log.	33635
E F		Logar.	55213		35° 9′ 0″	Ant.	20132 *S.*
				S F	29° 6′ 33″	Ant.	13503
Compl. of the elevat. of the pole				A S	35° 37′ 0″		
				A F	6° 30′ 27″	Ant.	646
				E F		Ant.	20132 *A.*
				Altit. of Capella		Log.	20778 54° 19′ 53″

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[Margin: Altitudo Capellæ.] *Altitude of Capella.*

Logar. of the perp. E F	55213					
Antil. of the altit. of Capella	53941 *S.*					
Logar. of the azimuth of Capella	1272	80° 53′ 12″	Azimuth of Capella			
		76° 51′ 0″	Azimuth of the comet.			
Angle E A C		4° 2′ 12″	Logarithm.	265363		
Compl. of the altitude		35° 40′ 7″	Logarithm.	53941 *A.*		
			Logarithm.	319304	E D	
Distance of the comet and Capella		23° 18′ 30″	Logarithm.	92716 *Subt.*		
			Logarithm of the angle	226588	E C D 5° 56′ 16″	
Mesolog. of the side C G, parall. of the orbit		10′ 55″		575228		

339 set unruled, in the page's own columns. The marks are printed over 128 7 43, 35 9 0 and 54 19 53 only; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own.

Antilog. of the angle E C D	5° 56′ 16″	538 *S.*	
Mesol. of the parallax reduced to the vertical		574690	10′ 59″

340

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*

Now let the prosthaphaeresis of inclination of the first equation be sought; it will be Subtractive, according to axiom 2 of the first class.

Diagram. Figure M, at the left of a block of three engraved figures: a spherical triangle with apex A; from a star at the left, dotted and full lines run to points on two near-vertical arcs, one inscribed "Orbita Cometæ" (the comet's orbit), with the arc of the ecliptic at the foot.

- A (apex, top): A
- along the right-hand arc: Orbita Cometæ. (orbit of the comet)
- upper end of the upper dotted line: I
- upper end of the second dotted line: D
- beside the star at the far left: E, its left part lost in the gutter shadow
- above the star, in script: [?]ell, its opening letter or letters lost in the gutter
- on the right-hand arc: F
- small circle on the right-hand arc: L
- small label at the lower left of the arcs: M
- small circle on the left-hand arc, lower: I
- along the foot arc: Ecliptica. (ecliptic)
- at the foot, along the ecliptic: H, B, C
- figure letter, lower left: M

Diagram. Figure N, the middle figure: a circle crossed by the ecliptic, the equator, the horizon M L, the comet's orbit and great circles through A; the star E is marked with an asterisk.

- top of the circle: A, F
- upper left rim: an engraved sign, not identified [?]
- left rim: P, M, X
- along the inner lines: Ecliptica. (ecliptic), Æquator. (equator), Horizon. (horizon), Orbita Cometæ. (orbit of the comet)
- beside the star: Capel. (Capella), E
- about the star and the comet: G, D, I, C
- upper right rim: S; right rim: R, L
- interior points: T, K, O
- lower right rim: N

[340] set unruled, in the page's own columns; the calculation continues that of the previous page. The marks are printed only over 80 53 12, 5 56 16 of the ninth row, 10 55 and 10 59; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 10 55 or 10 59. The tags *A.*, *S.* and *Subt.* are the page's own.

- lower interior: Occidens. (west)
- figure letter: N
- below the circle, in script: Hor 2 6 0 m. (2^h 6^m 0^s in the morning)

Diagram. Figure O, at the right: a circle crossed by the ecliptic, the equator, the horizon M L, the comet's orbit and great circles through A; the star B is marked with an asterisk, and dotted lines join V, H, E and I about B and C.

- top of the circle: A; upper right rim: S
- about the star: V, H, Cop. (Capella), B, E, D, I
- the comet: C
- left rim: an engraved sign of the same form as in figure N, not identified [?]; M
- along the inner lines: Ecliptica. (ecliptic), Æquator. (equator), Horizon. (horizon), Orbita Cometæ. (orbit of the comet)
- right rim: L; lower right rim: N; foot of the circle: X
- interior points: K, O
- lower interior: Meridies. (south)
- figure letter: O
- below the circle, in script: Hor 9 0′ 34″ [?]. (9^h 0^m 34^s; the last sort before the point not settled)
- lower right of the plate frame, in script: Autor Sculps. (the author engraved it)

For the altitude of Capella at 9^h 0^m 34^s.

Right asc. of the midheaven, from the earlier calc.	51° 32′ 18″					
Right asc. of Capella	72° 46′ 0″					
Compl. to 360, dist. from the meridian	21° 13′ 42″	Logar.	101585			
Declin. of Capella	45° 35′ 30″	Antil.	35701 *A.*	Logar.	33635	
B V	14° 40′ 32″	Logar.	137286 B V	Antil.	3317 *S.*	
Antilogarithm. V A	702			Antil.	30318	42° 24′
Antilogarithm. B V	3317 *A.*			Compl. of the elevat. of the pole		35° 37′
Ant. A B, or Log. B K	4019	Altitude of Capella	73° 52′			6° 47′ V A
		Altitude of the comet	67° 26′			
		Differ. of the altit. of the comet and Capella	6° 26′			

[341] set unruled, in the page's own columns. The marks are printed only over 42 24 and 73 52; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own.

[Margin: Altitudo Capellæ] *Altitude of Capella*
For the angle B A C.

Compl. of the altitude of the comet	C A	22° 34′	Logarithm.	95774	
Compl. of the altit. of Capella	B A	16° 8′	Logarithm.	128059 *Ad.*	
Difference		6° 26′		223833	Earlier aggregate
Distance of the comet and Capella	C B	23° 16′			
Sum		29° 42′			
Half		14° 51′	Logarithm.	136145	
Difference		16° 50′			
Half		8° 25′	Logarithm.	192161 *A.*	
			Later aggregate	328306	

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Later aggregate	328306		
Earlier aggregate	223833 *S*		
	104473		
Half-angle, Logar.	52236	36° 22′ 40″	
Whole angle B A C		72° 45′ 20″	

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Inquiry into the angles A C D and A C B, and the parallactic angle of inclination, namely of the first equation, B C D.

Angle	B A C	72° 45′ 10″	Logarithm.	4601	
Compl. of the altitude of Capella		16° 8′ 0″	Logarithm.	128059 *A.*	
			Logarithm.	132660	
Distance of the comet and Capella		23° 16′ 0″	Logarithm.	92884 *S.*	
			Logarithm of the angle	39776	42° 12′ 30″ B C A
Angle	B A C	72° 45′ 10″	Logarithm.	4601	

342 set as above; no marks are printed in this calculation; they are supplied in the house form; no figure is supplied. The tag *Ad.* after 128059 is printed so, where the page elsewhere sets *A.*; *A.* is the page's own.

343 set unruled, in the page's own columns; the calculation continues that of the previous page. The marks are printed over 36 22 40 only; the rest are supplied in the house form. The tag *S* is the page's own.

Compl. of the altit. of the comet		22° 34′ 0″	Logarithm.	95774 *A.*		
Perpendic.	D E		Logarithm.	100375	21° 30′ 0″	D E
Compl. of the altit. of the comet		22° 34′ 0″	Antilogarith.	7966		
Perpend.	D E	21° 30′ 0″	Antilogarith.	7212 *S.*		
	A E		Antilogarith.	754	7° 1′ 40″	A E
			Compl. of the altit. of the comet		22° 34′ 0″	A C
Side	E C	15° 32′ 20″	Logarithm.	131718 + *S.Cosf.*	15° 32′ 20″	E C
Perpend.	D E	14° 55′ 43″	Mesologar.	93163 +		
Angle	D C A		Mesologar.	38555 —	55° 46′ 55″	D C A
					42° 12′ 30″	B C A
			Angle of inclination sought		13° 34′ 25″	D C B

344

[Margin: Angulus inclinationis.] *Angle of inclination.*
For the parallax of the first equation.

Parallax reduced to the vertical	C B	10′ 59″	Logar.	574690	
Angle of inclination	B C D	13° 34′ 25″	Logar.	144985 *A.*	
There results the prosth. of inclinat. of the first equat.			Logar.	719675	2′ 35″ *Subt.*
The parallax reduced to the vertical was					10′ 59″
Therefore the vertical parallax, first equated					8′ 24″

345

[Margin: Parallaxis verticalis primò coæquata.] *The vertical parallax, first equated.*
For the prosthaphaeresis of the second equation, B D. *Subtr.*

344 set unruled, in the page's own columns. The marks are printed over the first row and over 42 12 30 of the fifth only; the rest are supplied in the house form; no figure is supplied. The angle B A C is printed 72 45 10 in the first and sixth rows, where the page's preceding line prints the whole angle 72 45 20, twice the half-angle 36° 22′ 40″; the perpendicular D E is printed 14 55 43 in the fourteenth row, where the eighth and tenth rows print D E 21 30 0; both are kept as printed. The signs + and — and the tags *A.*, *S.* and *S.Cosf.* are the page's own.

345 set as above; the marks are printed over 10 59 of the first row and over 2 35 only; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before the minutes. The tags *A.* and *Subt.* are the page's own.

1	Hyp. C B, dist. of the comet and Capella		23° 16′ 0″	Logar.	92884 *S.*			
	Perpendicul. C H, or D E		21° 30′ 0″	Logar.	100375			
	Angle H B C, or D B C			Logar.	7491		68° 6′	
				Compl. to 180°			111° 54′	D B C
2	Hyp. C B, dist. of the comet and Capella		23° 16′ 0″	Logar.	92884			
	Angle of inclin.	D C B	13° 34′ 25″	Logar.	144985 *A.*			
	Perpend.	B I		Logar.	237869		5° 19′	B I
3	Hyp. C B, dist. of the comet and Capella		23° 16′ 0″	Mesol.	84402	+ *S. Cosf.*		
	Perpend.	B I	5° 19′ 0″	Mesol.	237450	+		
	Angle	C B I		Antil.	153048	+	77° 30′	C B I
							111° 54′	D B C
				Angle of inclin. of the second equat.			34° 24′	I B D
4	Prosthaph. of inclin. of the first equat.		0° 2′ 35″	Mesol.	719349	+		
	Angle of inclin. of the second equat.		34° 24′ 0″	Antil.	19223	+ *S.*		
	Prosth. of inclin. of the second equat.	B D		Mesol.	700126	+	3′ 8″	*Subtrah.*
				Parall. reduced to the vertical was			10′ 59″	

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Therefore the genuine vertical parallax, equated a second time, is 7′ 51″, for the altitude of the comet 31° 12′ 13″, observed at 2^h 6^m 0^s in the morning on December 27.

This parallax is smaller by nearly three minutes than the earlier one, found in the preceding calculation from the distances of the comet and the Bright Star of Aries, even though it was derived from the same observations. Yet this is to be imputed neither to a faltering calculation nor to the calculator's carelessness. Rather, first, in the parallel observation the comet stood below the fixed star and in approach toward it, where the parallax is in a certain manner carried the opposite way; second, this very distance was too near the vertical point, and the angle B A C, namely 72° 45′ 10″, was too obtuse; third, beyond all doubt some small error still lies hidden in the longitude and latitude either of the Bright Star of Aries or of Capella, as is clearly evident from our more

346 set unruled, in the page's own columns, the step figures 1 to 4 standing at the head of their first rows. The marks are printed over 23 16 0 of step 1, over 68 6, after 180, and over 3 8 only; the rest are supplied in the house form; no figure is supplied, and step 4 prints its leading 0 as set. The signs + and the tags *A.*, *S.*, *S. Cosf.* and *Subtrah.* are the page's own.

recent observations. Hence this parallax could not be extracted as accurately as from the earlier, preceding computation, in which everything stands duly and consistently. Meanwhile, however, you see that the parallax comes out not larger, but a little smaller still, for the same altitude. So one is certainly moved to wonder that, from so very different a situation of the comet with respect to the fixed star and the distances, no more perceptible difference has nonetheless emerged.

[Margin: Cur hæc inventa parallaxis priori minor ſit ?] *Why is the parallax found here smaller than the earlier one?*

We have therefore shown sufficiently how great the parallax was on the 27th at $2^h\ 6^m$ [?] in the morning. Let us now also see how great it was at the evening hour of the same day, and indeed from quite different observations and distances. I do not doubt, my lover of the stars, that once you are fired with zeal for the truth you will hasten to these calculations with no less eagerness than the most ardent spirit with which I did not refuse to undertake and work out all of them, although with immense and most tedious labour, for your benefit and that of others.

[Margin: Licet faſtidioſiſſimus fuerit labor, cupidiſſimo tamen animo Autor calculos hos parallaxium iniit.] *Though the labour was most tedious, the author undertook these calculations of the parallaxes with the most eager mind.*

First, then, we shall set up the calculation from two distances of the comet and Aldebaran taken with the sextant, although one distance, parallel to the horizon, was observed in the morning at $2^h\ 6^m\ 0^s$ in the west, whereas the vertical distance was observed in the evening at $5^h\ 38^m\ 10^s$ in the east — and indeed in the manner we have indicated, about fixed stars near the orbit.

Investigation of Parallax X, from the Distances of the Comet and Palilicium Taken with the Sextant, for December 27 [Inveſtigatio Parallaxeos X. Ex diſtantiis Cometæ & Palilicii Sext. captis. Ad diem 27 Decemb.]

1	Observ. at $2^h\ 6^m\ 0^s$ in the morning	Distance of the comet	22° 5′ 30″	IE
2	Observ. at $5^h\ 38^m\ 10^s$ in the evening	Distance of the comet	24° 16′ 30″	LE
	Differ. of the hours $15^h\ 32^m\ 10^s$	Difference of the dist.	2° 11′ 0″	or the fictitious or mean apparent motion.

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Now let this mean apparent motion be corrected, on account of the star's excessive distance from the orbit, so that the apparent motion reduced to the

[347]set unruled, in the page's own columns, the observation figures 1 and 2 at the head of their lines. The time marks are printed only over the first time, with no hour mark, and the angle marks only over the first distance; the rest are supplied in the house form; no figure is supplied.

orbit may result, by equating both distances of the comet, I E and E L, in Figure F on p. 218. This is done without difficulty, since the distance of Palilicium from the orbit is already known from Investigation VI.

Antil. of the earlier dist.	22° 5′ 30″	7625	IE.	
Antil. of the dist. of Palil. from the orb.	4° 38′ 0″	327 *S.*	EF.	
Antil. of the distance from the orbit, reduct.		7298		21° 37′ 27″
Antil. of the later dist. L E	24° 16′ 30″	9257		
Antil. of the distance from the orbit	4° 38′ 0″	327 *S.*		
Antil. of the dist. reduced to the orbit		8930		23° 51′ 20″ *S.*
Apparent motion reduced to the orbit				2° 13′ 53″
True motion from the table, corresponding to $15^h\ 32^m\ 10^s$				2° 20′ 5″

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Since, therefore, this motion is greater than the apparent one, according to axiom 5 on p. 180, the parallax of the orbit hence comes out as 6′ 12″.

[Margin: Parallaxis orbitæ.] *Parallax of the orbit.*

Let this be reduced again to the vertical, for the hour, namely $5^h\ 38^m\ 10^s$ in the evening, with the comet and Palilicium almost standing under one and the same vertical circle — almost, I say, standing under one and the same vertical circle. Hence the angle of the orbit and the vertical must first be investigated. That angle, however, will hardly be found without labour, since the altitude of the comet is not yet known to us.

For the altitude of the comet at $5^h\ 38^m\ 10^s$ in the evening, and the azimuth.

Right ascension of the Sun	277° 21′ 0″							
Elongation from the merid.	83° 2′ 30″							
Right asc. of the midheaven	0° 23′ 30″	excess over 360°						
Right asc. of the comet	46° 46′ 18″							
Distance from the merid.	46° 22′ 48″	Logar.	32304					
Declination of the comet	34° 26′ 23″	Antil.	19270 *A.*	CT		Logar.	56998	
	51574	Logar.	51574		36° 39′ 31″	Antil.	22040 *S.*	
				SF	45° 10′ 22″	Antil.	34958	

348 set unruled, in the page's own columns. The marks are printed only over 22 5 30 of the first row, over 21 37 27 and over the time 15 32 10; the rest are supplied in the house form; no figure is supplied. The tag *S.* is the page's own.

Antil. of the altitude	49146	Compl. of the elev. of the pole	SA	35° 37′ 0″		
Log. of the azimuth	2428	77° 25′ 26″ azim.	AF	9° 33′ 22″	Antil.	1397
			CF		Antil.	22040 *A.*
		Altit. of the comet		52° 17′ 7″	Logar.	23437

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[Margin: Altitudo Cometæ] *Altitude of the comet*
For the angle of the orbit and the vertical.

Angle of the orb. and the equat., for the 27th		63° 0′ 0″	Antilog.	78968	
Declination	D C	34° 26′ 23″	Antilog.	19270 *S.*	
Angle of the orbit and the declin.			Logarith.	59698	33° 24′ 0″ HCD
Compl. of the elev. of the pole	AB	35° 37′ 0″	Logarith.	54067	
Azimuth of the comet	K L, or B A S	77° 25′ 26″	Logarith.	2428 *A.*	
			Sum, Logarith.	56495	
Complem. of the declin.	CB	55° 33′ 37″		19270 *S.*	
Angle of the vertical and the declination			Logarith.	37225	43° 34′ 0″ BCS, or ICD
Angle sought, of the orbit and the vertical					10° 10′ 0″ ICG

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Mesolog. of the side C G, or parall. of the orbit		6′ 12″	631802	
Antil. of the angle I C G of the orbit and the vertical	10° 10′ 0″		1583 *S.*	
Mesol. of the parall. reduced to the vertical, C I			630219	6′ 18″ paral. reduced to the vertical

[349] set unruled, in the page's own columns. The marks are printed only over the first row, over 36 39 31 and over 77 25 26; the rest are supplied in the house form; no figure is supplied, and the 0 before 23 30 is printed. The tags *A.* and *S.* are the page's own.

[350] set as above. The marks are printed only over the first row and over 33 24 0; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own.

351

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*

Diagram. Figure P, the left of two engraved figures: a circle crossed by the ecliptic, the equator, the horizon M L, the comet's orbit and great circles through the top of the circle; the comet C is a small circle on its orbit, and dotted lines run from B and from C to S outside the circle.

- outside the circle, top: S
- top of the rim: R, A, F
- upper left rim: B
- on the comet's orbit: C (a small circle)
- inside: D, I, G, H, K
- ends of the horizon: M (left), L (right)
- foot of the comet's orbit: X
- along the inner lines: Ecliptica. (ecliptic), Horizon. (horizon), Æquator. (equator), Orbit. Comet. (orbit of the comet)
- lower interior: Oriens. (east)
- figure letter: P
- below the circle, in script: Hor. 5 38′. [?]0″ v. (5^h 38^m in the evening; the first figure of the seconds not settled)

Diagram. Figure Q, the right figure: a circle crossed by the ecliptic, the equator, the horizon M L, the comet's orbit and great circles through A; the star B is drawn as an asterisk, and dotted lines join V and E to B and run on toward C.

- top of the circle: A
- right rim: S, R
- upper left rim: V, P; above V, an engraved sign in script, not identified [?]
- about the comet: C (a small circle), H, D
- about the star: E, B, W
- on the horizon, at the foot of two arcs: K, O
- ends of the horizon: M (left), L (right)
- foot of the orbit: X
- along the inner lines: Eclipti[?] (ecliptic; the last letter not settled), Æquator (equator), Cometæ (of the comet), Horizon (horizon), Orbita (orbit)
- beside the star: Palil. (Palilicium)
- lower interior: Occidens. (west)
- figure letter: Q
- below the circle, in script: Hor. 2 6′ 0″ m. (2^h 6^m 0^s in the morning)
- lower right, in script: Autor ſculps. (the author engraved it)

[351] set as above, following the angle sought without a caption. The marks are printed over 6 12 and 6 18 only; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 6 12 or 6 18. The tag *S.* is the page's own.

To derive the prosthaphaeresis of inclination — in this place subtractive, according to axiom 5 for stars situated near the orbit — we need the altitude of the comet and of Palilicium at $2^h\ 6^m\ 0^s$ in the morning. The former is already known from calculation VIII; the latter, that of Palilicium, must still be computed.

Right asc. of the midheaven	128° 7′ 43″	from Calc. VIII, p. 230					
Right asc. of Palilicium	64° 1′ 45″						
Dist. from the merid.	64° 5′ 58″	Logar.	10586				
Declin. of Palil.	15° 46′ 12″	Antil.	3837 *A.*		Logar.	130278	
	BV	Logar.	14423	59° 57′ 37″	Antil.	69134 *S.*	
	SV			57° 8′ 28″	Antil.	61144	
	SA			35° 37′ 0″	Compl. of the elev. of the pole.		
	VA			21° 31′ 28″	Antil.	7229	
				BV	Antil.	69134 *A.*	
Altitude of Palilicium, Antil.	BA, or BT				Antil.	76363	27° 46′ 23″
		Altitude of the comet at the same time was					31° 12′ 13″
		Difference of the altitudes					3° 25′ 50″

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[Margin: Differentia altitudinum.] *Difference of the altitudes.*
For the angle B A C.

Differ. of the compl. of the altit. of the com. and Palil.	3° 25′ 50″		
Dist. of the comet and Palil., the earlier	22° 5′ 30″		
Half of the sum	12° 45′ 40″	Logar.	151012
Half of the differ.	9° 19′ 50″	Logar.	182068

[352] set unruled, in the page's own columns, continuing the calculation of the altitude of Palilicium for $2^h\ 6^m\ 0^s$ in the morning announced at the foot of p. 290. The marks are printed only over 128 7 43, 59 57 37 and 27 46 23; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own.

Later aggreg.			Logar.	333078		
Earlier aggregate, from the logarithms of the compl. of the altitudes				27864 *S.*	Comet. and Palil.	
Differ.				305214		
Half				152607	12° 33′ 20″	Half-angle
Angle sought, B A C					25° 6′ 40″	

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Inquiry into the angle C B A, D B A and D B C, of the parallactic inclination of the first equation.

Angle	B A C	25° 6′ 40″	Logarithm.	85715		
Compl. of the alt. of the com.	B A	58° 47′ 47″	Logarithm.	15626 *A.*		
			Logarithm.	101341		
Dist. of the com. and the star	B C	22° 5′ 30″	Logarithm.	97793 *S.*		
Angle sought	A B C		Logarithm.	3548	74° 49′ 34″	A B C
Angle	B A C	25° 6′ 40″	Logarithm.	85715		
Compl. of the alt. of Palil.		62° 13′ 37″	Logarithm.	12238 *A.*		
		Sum	Logarithm.	97953	22° 3′ 16″	D E
Compl. of the alt. of Palil.		62° 13′ 37″	Antilogar.	76362		
	D E	22° 3′ 16″	Antilogar.	7599 *S.*		
	A E		Antilogar.	68763	59° 49′ 1″	A E
					62° 13′ 37″	A B
Side	E B	2° 24′ 36″	Logarithm.	316887 + *S.Cosf.*	2° 24′ 36″	E B
Perpend.	D E	22° 3′ 16″	Mesologar.	90354 +		
Angle	D B A		Mesologar.	226533 —	84° 4′ 27″	D B A
					74° 49′ 34″	A B C
Angle sought, of the inclin.					9° 14′ 53″	D B C

[353] set as above. The marks are printed only over 12 33 20; the rest are supplied in the house form; no figure is supplied. The later aggregate is printed 333078, two less than the sum of the two logarithms above it, which is 333080; the following difference is taken from the printed figure.

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For finding the subtractive prosth. of the first equat.

Parall. reduced to the vertical	B C	6′ 18″	Logar.	630219	
Angle of inclinat.	D B C	9° 14′ 53″	Logar.	182815 *A.*	
There results the prosth. of inclin.	C W		Logar.	813034	1′ 1″ *Subt.*
Parall. reduced to the vertical was found					6′ 18″
Therefore the genuine vertic. parall., first equated					5′ 17″

355

[Margin: Parallaxis primò coæquata.] *The parallax first equated.*

Although this parallax will hardly be changed at all by the prosthaphaeresis of the second equation, let us nevertheless set down the calculation itself, so that you may recognise for yourself, rightly, that it is truly so.

For the subtractive prosth. of the second equat.

Hyp., the dist. of the com. and Palil.	C B	22° 5′ 30″	Logarithm.	97793 *S.*		
Perpend.	D E, that is B H	22° 3′ 16″	Logarithm.	97953		
Angle	B C D, or B C H		Logarithm.	160	86° 45′	B C D
Hyp., the dist. of the com. and Palil.	C B	22° 5′ 30″	Logarithm.	97793		
Angle of inclin.	D B C	9° 14′ 53″	Logarithm.	182815 *A.*		
Perpendic.	C W		Logarithm.	280608	3° 28′	C W perp.
Hyp., the dist. of the com. and Palil.	C B	22° 5′ 30″	Mesolog.	90209 + *S. Cos.*		
Perpendic.	C W	3° 28′ 0″	Mesolog.	280381 +		
Angle sought	B C W		Antilog.	190172 +	81° 25′	B C W
					86° 45′	B C D
Angle of inclinat. sought.					5° 20′	W C D
Prosth. of the inclination of the first equat.		1′ 1″	Mesolog.	813034		

[354] set as above. The marks are printed only over the first row and over 74 49 34 in the fifth; the rest are supplied in the house form; no figure is supplied. The signs + and — and the tag *S.Cosf.* are the page's own; the tags *A.* and *S.* likewise.

[355] set as above. The marks are printed after 6 18 in the first row and over 1 1; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 6 18, 1 1 or 5 17. The tag *Subt.* is the page's own.

Angle of inclin. W C D, just found		5° 20′ 0″	Antilog.	434 *S.*	
Prosth. of the inclinat. of the second equat.	C D		Mesolog.	812600	1′ 1″ *Subt.*
Parallax reduced to the vertical was					6′ 18″
Therefore the true vertical parall., equated a second time					5′ 17″

For the altitude of the comet of 52° 17′ 7″, observed at 5^{h} 38^{m} 10^{s} in the evening on December 27.[356]

[Margin: Proſthaphæreſis verticalis ſecundò coæquata, planè cum primò coæquatâ coincidit.] *The vertical prosthaphaeresis, equated a second time, coincides entirely with the one equated first.*

And so you see that the prosthaphaeresis of the second equation is entirely the same as the earlier one of the first equation, so that nothing at all is taken from it on that account.

Moreover, for the following parallactic calculation, let us again use observations entirely different from the earlier ones — and indeed altitudes and azimuths. In the earlier observation, namely in the eastern quarter, the comet and Palilicium stood under almost the same vertical; in the later one, however, each stood at almost an equal distance from the horizon. Let the distances of the comet and Palilicium therefore be sought first, and then also the remaining quantities that are needed, according to our method and the three earlier figures F, P and Q.

Investigation of Parallax XI, from the Distances of the Comet and Palilicium Computed, for December 27 [Inveſtigatio Parall. XI. Ex Diſtantiis Cometæ & Palilicii ſupputatis ad diem 27 Decembr.]

1.	Observ. at	5^{h} 50^{m} 9^{s}	altit. of the comet	55° 6′ 0″	Azimuth, east	72° 19′	under the same vertic. circ.
2.	Observ. at	11^{h} 44^{m} 31^{s}	altit. of the comet	51° 52′ 40″	Azimuth, west	79° 36′.	

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[356] set unruled, in the page's own columns. The marks are printed only over the first row, over 86 45 in the third (degree and minute only) and over 1 1 in the fourteenth; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 1, 6 18 or 5 17. The signs + and the tags *S. Coſs.*, *A.*, *S.*, *Subt.* are the page's own. The words "For the altitude" close the last row on the page and run on into the line below.

[357] set unruled, in the page's own columns. The marks are printed over the first row only, as ° ′ ″ over the time and over the altitude and ° ′ over the azimuth; the rest are supplied in the house form; no figure is supplied, and no morning or evening is printed with either time.

Longitude of the comet, 1st observ.	23° 34′ 26″ ♉	Lat. of the com., north	16° 21′ 14″	Latit. of Palil.	5° 29′ 57″ south
Longit. of Palilicium	4° 57′ 8″ ♊	Complem.	73° 38′ 46″	Dist. from the pole	95° 29′ 57″
Angle I A D	11° 22′ 42″				

Logar. of the compl. of the latit. of the com.	A I	4131		An-til.	126740	
Logar. of the angle	I A D	162311 *A.*				
Log. of the perpend.	I D	166442	10° 54′ 43″	An-til.	1824 *S.*	
Antilogarithm	D E	7675		An-til.	124916 A D	73° 20′ 13″
Antilog.	I D	1824 *A.*			A E	95° 29′ 57″
Antilog.	I E	9499	24° 34′ 55″	Earlier dist. of the com. and Palil.	D E	22° 9′ 44″

358

[Margin: Diſtantia Cometæ & Palilicii prior.] *The earlier distance of the comet and Palilicium.*

Longitude of the comet, 2nd observ.	23° 23′ 24″ ♉	Latitude of the comet, north	17° 5′ 57″
Longitude of Palilicium	4° 57′ 8″ ♊	Complement.	72° 54′ 3″
Angle L A K	11° 33′ 44″		

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Logar. of the compl. of the latitud. of the com.	AL	4521	An-til.	122409	
Logar. of the angle	LAK	160726 *A.*			
Log. of the perp.	LK	165247	11° 2′ 41″	An-til.	1869 *S.*
Antilog.	KE	8232	An-til.	120540AK	72° 34′ 5″

358 set as above. The marks are printed over 23 34 26, 16 21 14, 5 29 57, 10 54 43 and 73 20 13; the rest are supplied in the house form; no figure is supplied. The signs ♉ and ♊ and the tags *A.* and *S.* are the page's own.

359 set as above. The marks are printed over 23 23 24 and 17 5 57 only; the rest are supplied in the house form; no figure is supplied. The signs ♉ and ♊ are the page's own.

Antilog.	LK	1869 *A.*			AE	95° 29′ 57″
Antilog.	LE	10101	25° 19′ 20″	Distance of the comet and Palil., the later	KE	22° 55′ 52″
	LI		24° 34′ 55″	Distance of the comet and Palil., the earlier.		
Difference of the distances			44′ 35″	or the mean apparent motion.		

360

[Margin: Motus visus medius.] *The mean apparent motion.*

For the reduction to the vertical, the angle of the orbit and the vertical found in the preceding investigation for $5^h\ 38^m\ 10^s$ can safely be used, if three or four seconds need not be attended to. Nevertheless, for the sake of the curious, it is better to derive that angle anew for the hour $5^h\ 50^m\ 9^s$.

1	Antil. of the earlier dist.	EI	24° 34′ 55″ 499		
	Antil. of the dist. of Palil. from the orbit	EF	4° 38′ 0″ 327 *S.*		
	Antil. of the earlier dist., reduced	IF	9172	24° 10′ 0″	
	Antil. of the later dist.	EL	25° 19′ 20″ 6101		
	Antil. of the dist. of the star from the orb.	EF	4° 38′ 0″ 327 *S.*		
	Antil. of the later dist., reduced	LF	9774	24° 55′ 20″	
	Therefore the apparent motion reduced to the orbit			45′ 20″	
	The true motion, however, from the tab., for $5^h\ 54^m\ 12^s$			47′ 15″	Since, therefore, the apparent motion is the smaller [?],
	the parallax of the orbit comes out at			1′ 55″	

361

[360] set unruled, in the page's own columns, continuing Investigation XI from the previous page. The marks are printed only over 11 2 41, 72 34 5 and 25 19 20; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 44 35. The tags *A.* and *S.* are the page's own. The difference is printed 44 35, where 25° 19′ 20″ less 24° 34′ 55″ gives 44′ 25″; the printed figure is kept.

[361] set as above. The marks are printed only over 24 34 55 and 24 10 0, and on the minutes and seconds of the time 5 54 12; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 45 20, 47 15 or 1 55. The tags *S.* are the page's own. The words "Since, therefore …" close the true-motion row on the page and run on into the row below.

2	Angle of the orb. and the equat., for the 27th		63° 0′ 0″	Antilog.	78968	
	Declination	D C	34° 27′ 56″	Antilog.	19299 *S.*	
	Angle of the orbit and the declin.			Logarith.	59669	33° 24′ 39″ HCD
	Compl. of the elev. of the pole	AB	35° 37′ 0″	Logarith.	54067	
	Azimuth of the comet	KS, or BSA	72° 19′ 0″	Logarith.	4846 *A.*	
				Logarith.	58907	
	Complem. of the declin.	CB	55° 32′ 4″	Logarith.	19299 *S.*	
	Angle of the vertical and the declination			Logarith.	39608	42° 17′ 46″ BCS, or ICD
	Angle sought, of the orbit and the vertical					8° 53′ 7″
	Mesolog. of the side C G, or parall. of the orbit		1′ 55″		749198	
	Antil. of the angle ICG of the orbit and the vertical		8° 53′ 7″		1207 *S.*	
	Mesol. of the parall. reduced to the vertical	CI			747991	1′ 57″

362

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*

For computing the additive prosthaphaeresis of the first equation.

1. Let the altitude of Palilicium be sought for $11^h\ 44^m\ 31^s$.

Right ascension of the Sun		277° 37′ 59″						
Elongation from the merid.		176° 7′ 45″						
Right asc. of the midheaven		93° 45′ 44″	Sum, with 360° cast off					
Right asc. of Palilicium		64° 1′ 45″						
Distance from the merid.		29° 43′ 59″	Logar.	70125				
Declination of Palilicium		15° 46′ 12″	Antil.	3837 *A.*	Declinat.		Logar.	130278
	BV		Logar.	73962	28° 30′ 32″		Antil.	12928 *S.*

[362] set as above. The marks are printed only after 63 0 0, over 33 24 39 and after 1 55 and 1 57; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 55 or 1 57. The tags *A.* and *S.* are the page's own. The sum of 54067 and 4846 is printed 58907, where the two logarithms above it give 58913; the following difference is taken from the printed figure.

	SV	71° 59′ 3″		An-til.	117350	
Compl. of the elev. of the pole	SA	35° 37′ 0″				
	AV	36° 22′ 3″		An-til.	21663	
			BV	An-til.	12928 *A.*	
Altitude of Palil., Antilog. BA, or Log. BT					34591	45° 2′ 16″
Altitude of the comet at the same time was						51° 52′ 40″
			Difference of the altitud.			6° 50′ 24″

363

For the angle B A C.

Compl. of the altit. of the comet	C A	38° 7′ 20″	Logar.	48234	
Compl. of the altit. of Palilic.	B A	44° 57′ 44″	Logar.	34723 *A.*	
Difference		6° 50′ 24″	Logar.	82957	Earlier aggreg.
Dist. of the comet and Palil., the later	B C	25° 19′ 20″			
Sum		32° 9′ 44″			
Half		16° 4′ 52″	Logar.	128374	
Difference		18° 28′ 56″			
Half		9° 14′ 28″	Logar.	182890 *A.*	
			Later aggregat.	311264	
			Earlier aggregat.	82957 *S.* 228307	
			Half-angle, Logar.	114153	18° 37′ 21″
			Angle BAC		37° 14′ 42″

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For the angle ABC, ABD and CBD of the parallax of inclination of the first equat., and the prosthaph. of the same.

[363] set as above. The marks are printed only after 277 37 59 and 28 30 32 and over 45 2 16; the rest are supplied in the house form; no figure is supplied. The "gr." of the cast-off 360 is set as the degree mark. The tags *A.* and *S.* are the page's own. On the page SV, SA, AV and BV stand near the middle of the measure.

[364] set unruled, in the page's own columns. The marks are printed only after 38 7 20 and over 18 37 21; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own.

Angle	BAC	37° 14′ 42″	Logarithm.	50217	
Compl. of the altit. of the com.	AC	38° 7′ 20″	Logarithm.	48234 *A.*	
Sum			Logarithm.	98451	
Dist. of the com. and Pal.	BC	25° 19′ 20″	Logarithm.	84930 *S.*	
Angle			Logarithm.	13521	60° 52′ 16″ ABC.
Angle	BAC	37° 14′ 42″	Logarithm.	50217	
Compl. of the altit. of Palil.		44° 57′ 44″	Logarithm.	34723 *A.*	
Perpendic.	DE		Logarithm.	84940	25° 19′ 12″ DE
Compl. of the altit. of Pal.	AB	44° 57′ 44″	Antilogarith.	34592	
Perpend.	DE	25° 19′ 12″	Antilogarith.	10099 *S.*	
	AE		Antilogarith.	24493	38° 29′ 10″ AE
			Compl. of the altitud. of Palil.		44° 57′ 44″ AB
Side	EB	6° 28′ 34″	Logarithm.	218223 + *S. Cofs.*	6° 28′ 34″ EB
Perpend.	DE	25° 19′ 12″	Mesologar.	74839 +	
Angle	DBA		Mesologar.	143384 —	76° 35′ 29″ DBA
					60° 52′ 16″ ABC
			Angle of inclinat. sought		15° 43′ 13″ DBC

365

[Margin: Angulus inclinationis.] *The angle of inclination.*
For the parallax of the first equation.

Parallax. reduced to the vertical	C B	1′ 57″	Logar.	747991	
Angle of inclination	CBD	15° 43′ 13″	Logar.	130586 *A.*	
There comes out the prosthaph. of the inclinat. of the first equat.	CW		Logar.	878577	0′ 32″ *A.*
Parallax. reduced to the vertical was					1′ 57″
The vertical parallax, first equated					2′ 29″

366

[Margin: Parallaxis verticalis primò coæquata.] *The vertical parallax first equated.*

[365]set as above. The marks are printed only over 37 14 42 in the first row and over 60 52 16 in the fifth; the rest are supplied in the house form; no figure is supplied. The signs + and — and the tag *S. Cofs.* are the page's own; the tags *A.* and *S.* likewise.

[366]set as above. The marks are printed after 1 57 in the first row and after 0 32; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 57, 0 32 or 2 29. The tags *A.* are the page's own.

For the prosthaphaeresis of inclin. of the second equat., BD, likewise to be added.

1.	Hyp., the distant. of the com. and Palil.	CB	25° 19′ 20″	Logar.	84930 *S.*		
	Perpend.	DE, which equals BH	25° 19′ 12″	Logar.	84940		
	Angle	BCD, or BCH		Logar.	10	89° 11′ 0″	BCD
2.	Hyp., the dist. of the com. and Palil.	CB	25° 19′ 20″	Logar.	84930		
	Angle of inclination	DBC	15° 43′ 13″	Logar.	130586 *A.*		
	Perpendicular	CW		Logar.	215516	6° 39′ 0″	CW
3.	Hyp., the dist. of the com. and Palil.	CB	25° 19′ 20″	Mesol.	74855 +	*Subt. Cosf.*	
	Perpendic.	CW	6° 39′ 0″	Mesol.	214911 +		
	Angle sought	BCW		An-tilog.	140056 +	75° 44′ 0″	BCW
						89° 11′ 0″	BCD
	Angle of inclin. of the second equation					13° 27′ 0″	WCD

367

4.	Prosth. of the inclin. of the first equat.	C W	0′ 32″	Mesol.	878577 +		
	Angle	W C D	13° 27′ 0″	An-til.	2781 + *S.*		
	Prosth. of the inclinat. of the second equat.	C D		Mesol.	875796 +	0′ 33″ *A.*	
	Parallax reduced to the vertical was					1′ 57″	
	Therefore the genuine vertical parallax, equated a second time					2′ 30″	

For the altitude of the comet of 55° 6′ 0″, observed at 5^{h} 50^{m} 9^{s} in the evening on December 27.[368]

Since this parallax seems almost too slight, we shall compute it once more from the same observations, but from entirely different distances, namely those

[367] set as above. The marks are printed only over 25 19 20 in the first row, over 89 11 0 in the third and over 6 39 0 in the sixth; the rest are supplied in the house form; no figure is supplied. The signs + and the tags *S.*, *A.* and *Subt. Cosf.* are the page's own.

[368] set unruled, in the page's own columns, continuing the calculation of the previous page. The marks are printed only after 0 32 and 0 33; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 0 32, 0 33, 1 57 or 2 30. The signs + and the tags *A.* and *S.* are the page's own. The words "For the altitude" close the last row on the page and run on into the line below.

of the comet and of the fixed star in the bend at the hips of Cassiopeia. Relative to that star, indeed, the comet had a position far different from its position relative to Aldebaran: with respect to Palilicium it was receding, but with respect to this fixed star it was approaching. Then, in the earlier observation, this star at the hips of Cassiopeia stood very close both to the orbit and to the vertical, and in the later observation on a parallel [?] below the perpendicular B H. Since this is an entirely different configuration of the phenomenon, it will become known all the more truly whether some fault lies hidden in the calculation or rather in the observations themselves. The procedure of the whole operation, however, is entirely the same, except that diagrams R and S are to be substituted in place of F and Q.

[Margin: Genuina parallaxis verticalis ad diem 27 hor. veſp.] *The genuine vertical parallax for the 27th, at the evening hour.*

Investigation of Parallax XII, from the Distances of the Comet and the Fixed Star at the Hips of Cassiopeia, to Be Computed, for December 27 [Inveſtigatio Parallaxeos XII. Ex diſtantiis Cometæ & Fixæ ad Coxas Caſſiopeæ ſupputandis, ad diem 27 Decemb.]

For the earlier distance E I.

1	Obs. at	$5^h\ 50^m\ 9^s$ in the evening	altit. of the comet	55° 6′ 0″	Azim. 72° 19′	east	*Vert.*
2	Obs. at	$11^h\ 44^m\ 31^s$ in the evening	altit. of the comet	51° 52′ 40″	Azim. 79° 36′	west	*Parall.*

369

Long. of the com. at the 1st obs.	23° 34′ 26″ ♉	Latit. of the com., north	16° 21′ 14″	Latit. of the star, north	48° 46′ 30″
Long. at the hips of Cass.	9° 11′ 42″ ♉	Complem.	73° 38′ 46″	Complem.	41° 13′ 30″
Angle E A D	14° 40′ 38″				

Logar. of the compl. of the latit. of the fixed star	A E	41699	41° 13′ 30″	An- til.	28484
Log. of the angle	E A D	139298 *A.*			

[369] set unruled, in the page's own columns. The marks are printed over the first row only, on the minutes and seconds of the time, over the altitude and as ° ′ over the azimuth; the rest are supplied in the house form; no figure is supplied. *Vert.* and *Parall.* stand one above the other at the right of the two rows, as printed.

Log. of the perpend.	E D	1809979	25′ 9″	Antil.	1358 *S.*	
Antilog.	D I	17963		Antil.	27126	40° 19′ 20″ D
Antilog.	E D	1358 *A.*				73° 38′ 40″ I
Antilog.	E I	19321	34° 29′ 0″ Distance of the comet and the fixed star, the earlier.			33° 19′ 20″ I

370

For the later distance E L.

Longit. of the com., later obs.	23° 23′ 24″ ♉	Latit. of the comet, north	17° 5′ 57″
Longit. at the hips of Cass.	9° 11′ 42″ ♉	Complem.	72° 54′ 3″
Difference E A K	14° 11′ 42″		

Logar. of the compl. of the latit. of the fixed star	E A	41699	41° 13′ 30″	Antil.	28484	
Log. of the ang.	E A K	140559 *A.*				
Log. of the perpend.	E K	182258	9° 18′ 1″	Antil.	1323 *S.*	
Antil.	K L	17093		Antil.	27161	40° 20′ 43″ K
Antil.	E K	1323 *A.*		Compl. of the latit. of the comet		72° 54′ 3″ L
Antil.	E L	18416	33° 42′ 57″ Later dist. of the comet and the fixed star, E L			32° 33′ 18″ L
			34° 29′ 0″ Earlier dist. of the comet and the fixed star, E I			
Mean apparent motion			46′ 3″			
Proper motion from the table			47′ 15″			
Mean or fictitious parall.			1′ 12″			

[370] set as above. The marks are printed over 23 34 26, 16 21 14 and 48 46 30 and after 41 13 30 and 34 29 0; the rest are supplied in the house form; no figure is supplied. The sign ♉ and the tags *A.* and *S.* are the page's own. The angle E A D is printed 14 40 38, where 23° 34′ 26″ less 9° 11′ 42″ gives 14° 22′ 44″; the printed figure is kept.

371

[Margin: Parallaxis media.] *The mean parallax.*
For the distance of the fixed star from the orbit of the comet.

Longit. of the fixed star at the hips of Cass.		9° 11′ 42″ ♉					
Point of intersect. of the orb. and the eclipt.		28° 31′ 0″ ♉					
Difference	G H	19° 19′ 18″	An-til.	5797			
Latitude of the fixed star	G E	48° 46′ 30″	An-til.	41699 *A.*	Latitud.	Logar.	28484
Hyp.	H E		An-til.	47496	51° 32′ 40″	Logar.	24450 *S.*
Angle	G H E	73° 50′ 0″				Logar.	4034
Angle of the orbit and the eclipt.	A H F	73° 57′ 0″ *S.*					
Remaining angle	E H F	7′ 0″				Logar.	619666
Hyp.	H E					Logar.	24450 *A.*
Distance of the fixed star from the orbit of the comet	E F	5′ 29″				Logar.	644116

372

[Margin: Diſtantia fixæ ab orbita.] *The distance of the fixed star from the orbit.*

Diagram. One engraved plate in a ruled frame, holding two figures side by side. At the left, figure R: a tall, narrow figure standing on an arc of the ecliptic. From A at the apex, arcs descend to H, C, B and G on the ecliptic; a line marked as the orbit of the comet crosses the figure obliquely; the fixed star at the hips of Cassiopeia stands as a star at E, with D and K to its left, joined to E by dotted lines; small circles mark L and I on the left-hand arcs; a large italic R stands in the middle. At the right, figure S: a circle with A at the top and the horizon drawn as an arc from M at the left to L at the right, O standing on it at the foot of the vertical from A. The comet's orbit runs from M across to L; on it lie the comet C, drawn as a small circle with H above it and D and W below, and the star B, marked as the star at the hips of Cassiopeia. S and V stand on the rim at the upper right, joined to B by a solid and a dotted line; E

371 set as above. The marks are printed over 23 23 24 and 17 5 57, after 41 13 30, and above 40 20 45 and 33 42 57; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 46 3, 47 15 or 1 12. The sign ♉ and the tags *A.* and *S.* are the page's own.

372 set unruled, in the page's own columns. The marks are printed only over 9 11 42 and after 51 32 40 and 5 29; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 7 0 or 5 29. The sign ♉ and the tags *A.* and *S.* are the page's own. On the page the rows from the first "Hyp." to the second stand to the right, under the logarithm columns.

stands above B, joined by a dotted line; P stands on the rim at the left and a script capital E on the rim at the upper left; K stands below the horizon at the right; the equator and the ecliptic run down to the rim at the lower right, the ecliptic to N; "the west" and a large italic S stand in the lower half. Below the circle is the hour legend, and at the lower right the engraver's signature.

- Figure R: A (apex); "Orbita Cometæ" (along the oblique line): the orbit of the comet; "Ad cox. Coſ." (beside the star E): at the hips of Cassiopeia; D, K (left of E); E (the star); L, I (small circles on the left-hand arcs); R (figure letter, middle); "Ecliptica" (the arc at the foot): the ecliptic; H, C, B, G (on the ecliptic).
- Figure S: A (top); E, in a script capital (rim, upper left); S, V (rim, upper right); P (rim, left); H, C, D, W (at the comet, left of centre); E (above B); B (the star); "Ad cox. Caſs." (beside B): at the hips of Cassiopeia; "Orbita" … "Cometæ." (along the arc from M to L): the orbit of the comet; M, L (ends of the horizon); "Horizon." (along the arc M–L): the horizon; O (on the horizon); K (below the horizon, right); the label on the upper of the two arcs at the lower right, its first letter an engraved script capital not separated between A and the Æ ligature, then "quator.": the equator; "Ecliptica." (the lower arc): the ecliptic; N (rim, lower right); "Occidens.": the west; S (figure letter, lower half); "Hor. 11 44′ 31″ v." (below the circle): at $11^h\ 44^m\ 31^s$ in the evening; "Autor ſculpſ." (lower right): the author engraved it.[373]

Since this distance is only a few minutes, no reduction to the orbit is therefore needed, but only a reduction to the vertical. You will carry this out very easily, because the angle of the vertical and the orbit is already known from the preceding inquiry, namely for the hour $5^h\ 50^m\ 9^s$; although, indeed, this vertical reduction too will contribute very little to the mean parallax, so that it could rightly be omitted.

[Margin: Nullâ reductione ad orbitam hîc opus eſt.] *No reduction to the orbit is needed here.*

For the reduction to the vertical.

Mesol. of the side C G, or of the fictitious parall., at the same time that of the orbit		1′ 12″	796025	
Antil. of the angle I C G of the orbit and the vertical		8° 53′ 7″	1207 *S.*	
Mesol. of the parallax reduced to the vertical	C I		794818	1′ 13″

[373] figure R carries 14 labels and figure S 26; all were read, the first letter of the equator's label only as one of two forms. The star's label is set "Coſ." in R, with o after the C, and "Caſs." in S, as engraved.

374

For the prosthaphaeresis of inclination, let there be sought 1. the altitude and azimuth of the fixed star at the hips of Cassiopeia for 11^{h} 44^{m} 31^{s}, and the angle B A C.

Right asc. of the midheaven	93° 45′ 44″							
Right asc. of the star	9° 6′ 0″							
Distance from the merid.	84° 39′ 44″	Log.		435				
Declination of the star	58° 51′ 0″	Ant.		65917 *A.*	De-cli-nat.	Log.	15570	
Logarithm.	66352	Perpend.	B V	Log. 66352	31° 0′ 0″	Ant.	15412 *S.*	
			S V		3° 13′ 0″	Ant.	158	
Antil. of the altit.	37093 *S.*	S A Compl. of the elev. of the pole			35° 37′ 0″			
Log. of the azim.	29259	48° 16′ 25″ azim. west	V A		32° 24′ 0″	Ant.	16921	
Azimuth of the comet		79° 36′ 0″	B V			Ant.	15412 *A.*	
Sum, compl. to 180°		52° 7′ 35″ ang. B A C.	Ant. B A, or B K			Log.	32333	46° 21′ 46″ alt. ✳
						Altitud. of the com.		51° 52′ 40″
						Different. of alt.		5° 30′ 54″

375

2. The angles A B C, A B D and C B D of the inclination of the first equation, and its prosthaphaeresis.

Angle B A C	52° 7′ 35″	Log. 23652
Compl. of the alt. of the com.	38° 7′ 20″	Log. 48234 *A.*

374 set unruled, in the page's own columns. The marks are printed only after 1 12 and 1 13; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 12 or 1 13. The tag *S.* is the page's own.

375 set unruled, in the page's own columns. The marks are printed only after 93 45 44, 31 0 0, 180 and 46 21 46; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the star sign ✳ are the page's own. On the page 79 36 0 and 52 7 35 stand under 48 16 25, and the last two rows stand at the right under the star's altitude.

		Log. 71886			
Dist. of the com. and ✱	33° 42′ 57″	Log. 58867 *S.*			
		Log. 13019	61° 23′ 33″	A B C	
Angle B A C	52° 7′ 35″	Log. 23652			
Compl. of the alt. of the fixed star	43° 38′ 14″	Log. 37093 *A.*			
		Log. 60745	33° 0′ 26″	D E perpend.	
Compl. of the alt. of the fixed star	43° 38′ 14″	Ant. 32335			
Perpendic. D E	33° 0′ 26″	Ant. 17602		Mesol. 43140 + D E	
		Ant. 14733	30° 20′ 37″	A E	
			43° 38′ 14″	A B	
Paral. reduced to the vert.	1′ 13″	Log. 794818	13° 17′ 37″	E B	Log. 146992 + *S.Cosf.*
Ang. of inclin.	42° 3′ 58″	Log. 40048 *A.*		Mesol. 103852 —	19° 19′ 35″ D B A
Prosth. of the incl. of the first eq. C W		Log. 834866	0′ 49″ *A.*		Angle 61° 23′ 33″ A B C
Parall. reduced to the vertical was			1′ 13″		Angle of inclinat. 42° 3′ 58″ D B C
Vertical parall., equated a first time			2′ 2″		

376

[Margin: Parallaxis primò coæquata verticalis.] *The vertical parallax, equated a first time.*

3. For the prosthaphaeresis of the second equation, additive.

Hyp. C B, distance of the com. and the fixed star	33° 42′ 57″	Logar. 58867 *S.*	
Perpend. D E, which equals B H	33° 0′ 26″	Logar. 60745	
Of the angle B C D, or B C H		Logar. 1878	78° 56′ B C D

376 set unruled, in the page's own columns, continuing the calculation of the previous page. The marks are printed as column heads over 52 7 35 at the head of the calculation, over 19 19 35, and after 0 49; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 13, 0 49 or 2 2. The tags *A.*, *S.* and *S.Cosf.*, the signs + and —, and the star sign ✱ are the page's own.

Hyp. C B, dist. of the comet and the fixed star	33° 42′ 57″	Logar. 58867		C B Mesol.	40446 + *S. Cosf.*	
Of the angle of inclination D B C	42° 3′ 58″	Logar. 40048 *A.*				
Of the perpendicular C W		Logar 98915	21° 50′	Mesol.	91468 +	
				Ang. B C W Antil.	51022 +	53° 6′
				Ang. B C D		78° 56′
Prosth. of the inclin. of the first C W	0′ 49″	Mesol. 834866		Angle of inclination W C D		25° 50′
Angle W C D	25° 50′ 0″	Antil. 10529 *S.*				
Prosth. of the sec. equat. C D		Mesol. 824337	0′ 54″ *Add.*			
Parall. reduced to the vertical was			1′ 13″			
Genuine vertical parall., equated a second time			2′ 7″	for the altit. of the com. 55° 6′, at $5^h\ 50^m\ 9^s$.		

377

It differs by only a very few seconds from the parallax derived in the preceding investigation, namely from the distances of the comet and Palilicium; and it is still, roughly, somewhat smaller than that one. So there is no fault whatever in the calculation; but if there is any, it lies hidden rather in the observations, above all in that later one made at $5^h\ 50^m\ 9^s$. Let us therefore continue with a further reckoning of this parallax, and in place of the earlier observation we shall use another, made at $5^h\ 40^m\ 48^s$, in which the altitude, together with the azimuth of the comet, was observed with the greatest care. From this observation, then, and from that later one at $11^h\ 44^m\ 31^s$, let us investigate the parallax through the distances of the comet and the Bright Star of Aries. For this fixed star stood, relative to the comet, in a very convenient configuration: at that time the comet was approaching the fixed star, while the star, for its part, lay at an almost right angle to the comet and its orbit. Moreover, in the earlier observation the distance ran parallel to the horizon, and in the later one, in turn, it was vertical. From this fitting position, for the altitude of the comet of 51° 52′ 40″, namely at $11^h\ 44^m\ 31^s$, with the fixed star and the comet under the sa-

[Margin: In calculo nihil omninò aberratum; cùm æqualis propemodùm parallaxis illâ præcedente calculo erutâ, inventa fuerit.] *No error at all was made*

377set as above. The marks are printed over 33 42 57 in the first row and after 78 56 (third row), 21 50, 53 6, 0 49, 0 54 and 55 6, and over the minutes and seconds of the time; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 0 49, 0 54, 1 13 or 2 7. The tags *A.*, *S.*, *S. Cosf.* and *Add.* and the signs + are the page's own.

in the calculation, since a parallax almost equal to the one derived by the preceding calculation has been found.

[Margin: Vlteriori ratiocinio eadem parallaxis inveſtigatur.] *The same parallax is investigated by a further reckoning.*

me vertical, nothing but a most accurate parallax is to be expected, one to be preferred to the two preceding ones found for about the same time. Since, however, the Bright Star of Aries held a position perpendicular to the comet and its orbit, we must now set up the operation differently from the way it was done in the preceding calculation, as we have already pointed out several times.

Investigation of Parallax XIII, from the Distances of the Comet and the Bright Star of Aries, to Be Computed, for December 27 [Inveſtigatio Parallaxeos XIII. Ex diſtantiis Cometæ & Lucidæ Arietis ſupputandis, ad diem 27 Decembr.]

For the earlier distance E I.

1	Obs. at	$5^h\ 40^m\ 48^s$ in the evening	altit. of the comet	53° 33′ 30″ Azim. 75° 14′ east	*Parall.*
2	Obs. at	$11^h\ 44^m\ 31^s$ in the evening	altit. of the comet	51° 52′ 40″ Azim. 79° 36′ west	Under nearly the same vertic.

[378]

Longit. of the com., 1st obs.	23° 52′ 20″ ♓	Latit. of the com.	16° 12′ 25″ north	Latit. of the Bright Star of ♈	9° 57′ 30″ north
Longit. of the Bright Star of ♈	2° 49′ 57″ ♉	Compl. A I	73° 47′ 35″	Complem.	80° 2′ 30″ A E
Angle I A D	21° 2′ 23″				

Logar. of the compl. of the latit. of the com.	A I	4055		Antil.	127616 A I
Log. of the angle	I A D	102435 *A.*			
Log. of the perpend.	I D	10649020° 10′ 3″		Antil.	6327 *S.*
Antilog.	D E	823		Antil.	121289 72° 42′ 57″ D
Antilog.	I D	6327 *A.*		Compl. of the latit. of the Bright Star of ♈	80° 2′ 30″ E

[378] set unruled, in the page's own columns. The marks are printed over the first row only, on the minutes and seconds of the time, over the altitude and as ° ′ over the azimuth; the rest are supplied in the house form; no figure is supplied. *Parall.* stands at the right of the first row and "Under nearly the same vertic." at the right of the second, as printed.

Antilog.	E I	7150	21° 24′ 33″	Dist. of the com. and the Bright Star of ♈, true and apparent at once.	7° 20′ 12″	E

379

For the later distance E L.

Longit. of the com., 2nd observ.	23° 23′ 24″ ♉	Latit. of the comet	17° 5′ 57″
Longitud. of the Bright Star of ♈	2° 49′ 57″ ♉	Complem.	72° 54′ 3″
Difference L A K	20° 33′ 27″		

Logar. of the compl. of the lat. of the com.	A L	4521			Antil.	122409	A L
Log. of the ang.	L A K	104655 *A.*					
Log. of the perpend.	L K	109176	19° 36′ 37″		Antil.	5975 *S.*	
Antil.	E K	1035			Antil.	116434	71° 48′ 44″ A K
Antil.	L K	5975 *A.*			Compl. of the latit. of ♈		80° 2′ 30″ E
Antil.	E L	7010	21° 12′ 15″	Dist. of the comet and the Bright Star of ♈, apparent.			8° 13′ 15″ K E
			21° 24′ 33″	Dist. of the comet and the Bright Star of ♈, the earlier.			
Differ. of the distances			12′ 18″				

380

With the distances thus found, let the angle F I E be computed, likewise from the accompanying Figure T; for the distance of the Bright Star of Aries

379 set as above. The marks are printed over 23 52 20, 16 12 25 and 9 57 30 and after 20 10 3 and 21 24 33; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 49 57 other than the printed 2. The sign ♉, the sign of Aries ♈ and the tags *A.* and *S.* are the page's own.

380 set as above. The marks are printed over 23 23 24 and 17 5 57, after 19 36 37, and as column heads over 71 48 44 and 21 12 15; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 12 18. The sign ♉, the sign of Aries ♈ and the tags *A.* and *S.* are the page's own. K E is printed 8 13 15, where 80° 2′ 30″ less 71° 48′ 44″ gives 8° 13′ 46″; the printed figure is kept.

from the orbit of the phenomenon has already been found above, in calculation VIII.

Logarithm of the hyp., the earlier distance	21° 24′ 33″	100779 *S.*	
Logarithm of the dist. of the Bright Star of ♈ from the orbit	21° 15′ 5″	101484	
Logarithm of the angle sought, F I E		705	82° 12′ 15″

381

For the reduction and limitation of the distance E I.

Proper motion from the table	L I	48′ 30″	Logar. 426104		Antil. 9.952	L I	
Of the angle	F I E	82° 12′ 15″	Logar. 705 *A.*				
Perpendic.	L M		Logar. 426809	48′ 10″	Antil. 9.816 *S.*		
Antil.	E M	7086			Antil. 0.136	I M	5′ 40″
Antil.	L M	10			Earlier distance	E I	21° 24′ 33″
Antil.	L E, or	7096	21° 19′ 49″ E I reduced.		Side E M in the triangle E M L		21° 18′ 53″
Later distance	E L		21° 12′ 15″ of the comet and the Bright Star of ♈.				
Parallax of the orbit			5′ 34″				

382

[Margin: Parallaxis Orbitæ.] *The parallax of the orbit.*

This is to be brought back to the vertical, as in- vestigation VIII was shown. For the calculation must be continued, since the earlier distance is greater than the later, and some parallax lies hidden here, according to axiom 2. This is done by seeking the angle E C D in Diagram V from the azimuths of the comet and of the Bright Star of Aries: the azimuth of the comet is indeed already given by the observation, while that of the star must first be determined; and so one must proceed further, step by step.

[Margin: Parallaxin ſubeſſe deprehenditur.] *A parallax is found to be present.*

Diagram. Figure T, at the left of the row of three figures: a spherical triangle with its apex A at the top, the comet's orbit drawn up its left side and the ecliptic along its foot, with dotted construction lines running from two

[381] set as above. The marks are printed after 21 24 33 and 82 12 15; the rest are supplied in the house form; no figure is supplied. The tag *S.* is the page's own. No figure T is printed on this page.

[382] set as above. The marks are printed after 48 30 and 48 10, and as column heads over 5 40 and over 21 19 49; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 48 30, 48 10, 5 40 or 5 34. The tags *A.* and *S.* and the sign of Aries ♈ are the page's own. The parallax of the orbit is printed 5 34, where 21° 19′ 49″ less 21° 12′ 15″ gives 7′ 34″; the printed figure is kept.

small circles on the left side to the star E. The figure is cut at the left by the gutter.

- A (apex, top): A
- running up the left side: *Orbita Cometa.* — orbit of the comet
- K (right side, upper): K
- D (right side, below K): D
- F (left edge, at the gutter): F
- L (left edge, beside the upper small circle): L
- M (below the lower small circle): M
- beside the star E: *Lucid.* ♈ — the Bright Star of Aries
- E (the star, right): E
- T (large figure letter, lower left): T
- along the foot: *Ecliptica.* — the ecliptic
- lower left corner, at the gutter: [?] (the right half of a sort, perhaps B)
- C (foot, left): C
- G (foot, right): G

No letter is seen beside the lower small circle on the left side, although the calculations cite I there; it may stand in the binding shadow.

Diagram. Figure V, in the middle: a circle with the horizon drawn across it, the equator and the ecliptic, the comet's orbit, and the vertical circles through the comet C and the star E. The caption under the circle gives the hour.

- rim, top: A
- rim, upper left: V
- rim, left of V: an engraved sign, an open C-shaped stroke with a small loop [?]
- rim, upper right: S
- rim, left: P
- C (the comet, on the orbit): C
- across the upper part: *Orbita Cometæ.* — orbit of the comet
- rim, right: R
- I (below C, left): I
- G (below C, right): G
- D (left of E): D
- beside E: *Lucid.* ♈. — the Bright Star of Aries
- E (the star): E
- rim, left: X
- left end of the horizon: M
- T (below D, left): T
- along the horizon: *Horizon.* — horizon
- right end of the horizon: L
- O and K (on the horizon, below the star): O, K
- lower right: *Æquator.* — equator
- lower left: *Occidens.* — west
- lower right, along a line: *Ecliptica.* — the ecliptic

- V (large figure letter, lower centre): V
- rim, bottom: N
- caption under the circle: *Hor. 11 44′ 31″ v.* — at 11^{h} 44^{m} 31^{s} *v.*

Diagram. Figure W, at the right: a circle drawn like V, for the earlier observation, with the comet C and the star B near the top and the small triangle H, C, D, w beside them.

- rim, top: S A
- rim, upper right: V
- H, C, D (left of the small triangle, top to bottom): H, C, D
- E (above B): E
- w (beside D): w
- B (the star): B
- beside B: *Luc.* ♈. — the Bright Star of Aries
- along the horizon, left: *Horizon.* — horizon
- across the centre: *Ecliptica.* — the ecliptic
- left end of the horizon: M
- right end of the horizon: L
- O and K (on the horizon): O, K
- lower left: *Æquator.* — equator
- lower centre: *Oriens.* — east
- running down from the top: *Orbita Cometæ.* — orbit of the comet
- W (large figure letter, lower centre): W
- rim, bottom: X
- caption under the circle: *Hor. 5 40′ 48″ v* — at 5^{h} 40^{m} 48^{s} *v*
- to the right of the caption: *Autor ſculps.* — engraved by the author

For the altitude of the Bright Star of Aries, the azimuth, and the angle E C D, at 11^{h} 44^{m} 31^{s}.

Right asc. of the midheaven	93° 45′ 44″			
Right asc. of the Bright Star of ♈	26° 57′ 0″ *S.*			
Dist. from the merid.	66° 48′ 44″	Logar. 8423		
Declin. of the Bright Star of ♈	21° 49′ 0″	Antil. 7432 *A.*	Declin.[383] Logar. 98983	
		E V Logar. 15855	58° 34′ 53″	Ant. 65145 *S.*
			S V	44° 31′ 34″ Antil. 33838
			S A	35° 37′ 0″
Logar. E V	15855		V A	8° 54′ 34″ Antil. 1214

[383] the page inks "Decltn."; recte: Declin.

Antil. of the altit.	15410		E V		Antil. 65145 *A.*	
Log. of the azim.	445	84° 36′ 0″ of the Bright Star of ♈	Ant. E A, or Log. E K	66359	30° 59′ 51″	altit. of the Bright Star of ♈
Azimuth of the comet		79° 36′ 0″	Altitude of the comet was		51° 52′ 40″	
Diff. K O, or angle E A C		5° 0′ 0″	Log. 244006	Difference of altit.	20° 52′ 49″	
Compl. of the altit. of the Bright Star of ♈		59° 0′ 9″	Log. 15385 *A.*			
		Perpend.	Log. 259391	4° 17′ 8″ E D	Log. 259391	
		Dist. of the comet, uncorr., C E hyp.	21° 12′ 15″		Log. 101696 *S.*	
			Of the angle sought, E C D	Log. 157695	11° 55′ 24″	

384

For the reduction to the vertical.

Mesol. C G of the parall., fictitious or of the orbit	5′ 34″	642577	
Antilog. of the angle E C D	11° 55′ 24″	2181 *S.*	
Mesolog. of the parall. reduced to the vertical		640396	5′ 41″

385

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*

Now, following the analysis of configuration W, let the prosthaphaereses of inclination be sought.

1. For the altitude of the Bright Star of Aries, at $5^h\ 40^m\ 48^s$.

384 set unruled, in the page's own columns. The marks are printed after 93 45 44, 58 34 53 and 4 17 8, and as column heads over 84 36 0, over 30 59 51 and over 11 55 24 (last row); the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the sign of Aries ♈ are the page's own.

385 set as above. The marks are printed after 5 34 and 5 41; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 5 34 or 5 41. The tag *S.* is the page's own.

Right asc. of the Sun	277° 21′ 12″	
Elongat. from the mer.	85° 12′ 0″	
Right asc. of the midheaven	2° 33′ 12″	360° cast off.

386

Right asc. of the Bright Star of ♈	26° 57′ 0″				
Distance from the merid.	24° 23′ 48″	Logar. 88417			
Declinat. of the Bright Star of ♈	21° 49′ 0″	Antil. 7432 *A.*	Declinat. Logar. 98983		
		B V Logar. 95849	22° 32′ 54″	Antil. 7953 *S.*	
		S V	66° 16′ 17″	Antil. 91030	
Logarithm 95849 B V		S A	35° 37′ 0″		
Antil. of the altit. 49874 *S.*		V A	30° 39′ 17″	Antil. 15053	
Log. of the azim. 45975	39° 9′ 23″ azim. east	B V		Antil. 7953 *A.*	
		Antil. A B or Log. B K		23006	52° 36′ 22″ altit.
		Altitude of the comet at the same time			53° 33′ 30″ of the Bright Star
		Differ. of altit.			57′ 8″ of ♈.

387

[Margin: Altitudo Lucidæ Arietis.] *The altitude of the Bright Star of Aries.*

The difference of altitude is therefore very small; for this reason the angle of inclination too will be very acute, and consequently each prosthaphaeresis is of almost no account. Nevertheless, let us go and seek them.

2. For the angle B A C.

[386] set as above. The marks are printed after 277 21 12; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 33 12 other than the printed 2.

[387] set unruled, in the page's own columns, continuing the calculation of the previous page. The marks are printed after 26 57 0, 22 32 54, 39 9 23 and 52 36 22; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 57 8. The tags *A.* and *S.* and the sign of Aries ♈ are the page's own; the tag "altit. lucid. ♈." runs down the right edge across the last three rows, as printed.

Compl. of the altit. of the comet C A	236° 26′ 30″	Logarithm 52086		
Compl. of the altit. of the Bright Star of ♈ B A	37° 23′ 38″	Logarithm 49876 *Ad.*		
Difference	57′ 8″	101962	Earlier aggreg.	
Distance of the com. and the Bright Star of ♈ B C	21° 24′ 33″			
Sum	22° 21′ 41″			
Half	11° 10′ 50″	Logarithm 164038		
Difference	20° 27′ 25″			
Half	10° 13′ 42″	Logarithm 172838 *A.*		
Later aggreg.		336876		
Earlier aggreg.		101952 [recte: 101962] *S*		
		234914		
Half-angle Logar.		117457		17° 59′ 46″
Whole angle B A C				35° 59′ 32″

388

3. Investigation of the angles A B C, A B D and C B D of the inclination of the parallax of the first equation.

Of the angle B A C	35° 59′ 32″	Logar. 53157				
Compl. of the altit. of the com. A C	36° 26′ 30″	Logar. 52086 *A.*				
Sum		Logar. 105243				
Dist. of the com. and the Bright Star of ♈	21° 24′ 33″	Logar. 100779 *S.*				
Angle sought A B C		Logar. 4464	73° 0′ 27″			
Angle B A C	35° 59′ 32″	Logar. 53157				
Compl. of the alt. of the Bright Star of ♈	37° 23′ 38″	Logar. 49876 *A.*		Antil. 22978		
Perpend.		Logar. 103033	D E 20° 54′ 33″	Antil. 6812 *S.*		
Side E B	5° 41′ 5″	Logar. 231209 + *S. Cosf.*		Antil. 16166	A E	31° 42′ 33″
Perpend. D E	20° 54′ 33″	Mesol. 96220 +			A B	37° 23′ 38″
Angle D B A		Mesol. 134989 —	75° 25′ 54″ D B A		E B	5° 41′ 5″

388 set as above. The marks are printed after 236 26 30 and 17 59 46; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 57 8. The first row is printed 236° 26′ 30″, where 90° less 53° 33′ 30″ gives 36° 26′ 30″, the value the next calculation prints for the same complement; the printed figure is kept. In the earlier aggregate of the tenth row the fifth figure is a 5. The third row prints 101962; it is the sum of its two logarithms (52086 + 49876), and 336876 − 101962 gives the printed 234914, so the 101952 of the tenth row is a misprint for 101962. The tags *Ad.*, *A.* and *S* are the page's own.

			73° 0′ 27″ A B C 2° 25′ 27″ D B C			

389

4. For finding the prosthaphaeresis of the first equation.

Parall. reduced to the vertical	5′ 41″	Logar. 640396			
Angle of inclinat. D B C	2° 25′ 27″	Logar. 316303 *A.*			
Result: prosth. of the inclin. C W		Logar. 956699		0′ 14″	Subt. prosthaph.
		Parallax reduced to the vertical		5′ 41″	
		Vertical parallax, equated a first time		5′ 27″	

390

It is, however, to be subtracted in this place: for the comet, as it approaches, then stands above the fixed star but below the perpendicular, according to axiom 1 of the first class.

[Margin: Proſthaphæreſis primæ æquationis ſubtrahenda eſt.] *The prosthaphaeresis of the first equation is to be subtracted.*

5. For the prosthaph. of the inclin. B D of the second equat. Subt.

Dist. of the com. and the fixed star C B	21° 24′ 35″	Log. 100779 *S.*				
Perp. D E or B H	20° 54′ 35″	Log. 103033				
Ang. B C D or B C H		Log. 2254	77° 53′ 0″ B C D			
Dist. of the com. and the fixed star C B	21° 24′ 35″	Log. 100779		Mes. 93600 + *S. Cosſ.*		
Angle of inclin. D B C	2° 25′ 27″	Log. 316303 *A.*				
		Log. 417082	C W 0° 53′ 8″	Mes. 416971 +		
Prosth. of the inclin. of the first eq. C W	0′ 14″	Mes. 956699		Ant. 323371 +	87° 45′	B C W
Ang. of inclin. of the 2nd equat.	14° 22′ 0″	Ant. 3177		Compl. of the angle B C D	102° 7′	B C D

389 set as above. The marks are printed as column heads over 35 59 32 (first row), over 73 0 27 (fifth row) and over 31 42 33; the rest are supplied in the house form; no figure is supplied. The tags *A.*, *S.* and *S. Cosſ.*, the signs + and —, and the sign of Aries ♈ are the page's own.

390 set as above. The marks are printed after 5 41 (first row) and 0 14; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 5 41, 0 14 or 5 27. The tag *A.* is the page's own.

Prosth. of the inclin. of the 2nd equat. C D	Mes. 953522	0′ 15″ Subt.	Ang. of inclinat.	14° 22′	W C D
	Parall. reduced to the vertical	5′ 41″			
Therefore the genuine vertical parallax, equated a second time at $11^h\ 44^m\ 31^s$ in the evening, observed on December 27.		5′ 26″	For the altitude of the comet	51° 52′ 40″,	

391

Since this is about two minutes greater than in the two preceding computations, we shall therefore compute the same parallax once more from the same observations, for the same altitude, and indeed from quite different distances, namely of the comet and Capella. In the west, namely in the vertical observation, Capella stood above the comet, as the Bright Star of Aries in the earlier calculation stood below it; moreover, Capella was in recession, the Bright Star of Aries in approach, not to mention that in the parallel observation Capella was placed above the perpendicular B H, the Bright Star of Aries below it. If, from this very different position of the fixed stars relative to the comet, almost the same parallax comes out of every calculation, you will judge quite rightly that it has been computed entirely and correctly, and that it is genuine.

[Margin: Pro majori rei certitudine denuò eadem ſupputatur parallaxis.] *For greater certainty in the matter, the same parallax is computed anew.*

[Margin: Si omninò eadem ex omni calculo provenit parallaxis, de obſervationibus & ſupputatione ſecuri prorsùs eſſe poſſumus.] *If entirely the same parallax results from every calculation, we can be wholly confident of the observations and of the computation.*

Investigation of Parallax XIV, from the Distances of the Comet and Capella, Computed, for December 27 [Inveſtigatio Parallaxeos XIV. Ex diſtantiis Cometæ & Capellæ ſupputatis, ad diem 27 Decemb.]

For the earlier distance. E L.

1	Observ. at $5^h\ 40^m\ 48^s$	Altit. of the comet	53° 33′ 30″	Azim. east	75° 14′	Parall.
2	Observ at $11^h\ 44^m\ 31^s$	Altit. of the comet	51° 52′ 40″	Azim. west	79° 36′	Vertical.

391 set unruled, in the page's own columns, continuing the calculation of the previous page. The marks are printed after 21 24 33 (first row), 77 53 0, 51 52 40 and the minutes and seconds of the hour; as column heads over 87 45 and over 0 15; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 0 14, 0 15, 5 41 or 5 26. The 0 before 53 8 is printed. The tags *A.*, *S.* and *S. Coſ.*, the sign +, and the abbreviation *Subt.* are the page's own.

392

Long. of the com., 1st obs.	23° 52′ 20″ ♉	Latit. of the com.	16° 12′ 25″ north	Latit. of Capell.	22° 52′ 15″
Long. of Capella	17° 0′ 12″ ♊	Complem.	73° 47′ 35″	Compl.	67° 7′ 45″
Angle L A K	23° 7′ 52″				

Log. of the compl. of the latit. of Capell.	8188		Antil. 94479	
Log. of the angle L A K	93438 *A.*			
Log. of the perpendicular	101626	21° 13′ 11″	Antil. 7021 *S.*	Antil. 7021
			Antil. 87458	65° 21′ 8″
			Compl. of the latit. of the com.	73° 47′ 35″
				8° 26′ 27″
				Antil. 1089 *A.*
E L	Distance of the com. and Capell., apparent and true together			22° 45′ 52″
				Antil. 8110

393

For the later distance E I, apparent.

Long. of the com., 2nd obs.	23° 23′ 24″ ♉	Latitud. of the comet	17° 5′ 57″ north
Long. of Capell.	17° 0′ 12″ ♊	Compl.	72° 54′ 3″
Angle I A D	23° 36′ 48″		

Log. of the compl. of the latit. of Capell.	8188	Antil. 94479	
Log. of the angle I A D	91489 *A.*		

[392] the time marks are printed only over the minutes and seconds of the first time, with no hour mark, and the angle marks only over the first altitude and after the 75; the rest are supplied in the house form. The words *Parall.* and *Vertical.* stand at the right ends of the two lines, one above the other, as printed.

[393] set unruled, in the page's own columns. The marks are printed after 23 52 20, 16 12 25, 22 52 15 and 21 13 11, and as column heads over 65 21 8; the rest are supplied in the house form; no figure is supplied. The signs ♉ and ♊ stand after the longitudes, as printed. The tags *A.* and *S.* are the page's own.

Log. of the perpendicular	99677	21° 39′ 36″	Antil. 7323 *S.*		Antil. 7323
			Antil. 87156	65° 16′ 21″	
			Compl. of the latit. of the com.	72° 54′ 3″	
				7° 37′ 42″	Antil. 890 *A.*
		Dist. of the com. and Capell., later, E I		22° 54′ 19″	Antil. 8213
		Dist. of the com. and Capell., earlier, E L		22° 45′ 55″	
		Difference of the distances		8′ 24″	

394

[Margin: Diſtantia Cometæ & Capell.] *Distance of the comet and Capella.*

For the angle F L E.

For the distance of Capella from the comet's orbit has already become known above.

Log. of the later distant.	22° 54′ 19″	94363	
Log. of the distant. from the orbit	22° 50′ 37″	94619 *S.*	
Log. of the angle F L E		323	85° 54′ 0″.

395

For the limitation of the later distance E I, since the comet is in recession.

Proper motion from the table L I	48′ 30″	Logar. 426104		Antil. 9.952		
Ang. F L E	85° 54′ 0″	Logar. 256				
Perpend. L M		Logar. 426360	48′ 22″	Antil. 9.892 *S.*		
Antil. E M 8169				Antil. 0.055	0° 3′ 38″	
Antil. L M 10 *A.*				Dist. E L of the comet and Capell.	22° 54′ 19″	
Antil. E I 8179	22° 51′ 30″	Dist. E I sought.		E M	22° 50′ 41″	
	22° 45′ 55″	Earlier dist. E L was				

[394] set as above. The marks are printed after 23 23 24, 17 5 57 and 21 39 36; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 8 24. The tags *A.* and *S.* are the page's own.

[395] set unruled, in the page's own columns. The marks are printed after 22 54 19 and 85 54 0; the rest are supplied in the house form; no figure is supplied. The tag *S.* is the page's own. The page prints 323 for the logarithm of the angle, where the difference of the two logarithms above it is 256, the value used in the next calculation; the printed figure is kept.

Parall. of the orbit	5′ 35″	or reduced.

396

[Margin: Parallaxis Orbitæ.] *Parallax of the orbit.*

For the later distance is greater than the earlier; and therefore, according to axiom 5, let us continue the calculation, and reduce the parallax just found to the vertical with the help of Diagram Y.

1. For the altitude and azimuth of Capella, and the angle E C D, or I C G, at 11^{h} 44^{m} 31^{s} in the evening.

Right asc. of the midheaven	93° 45′ 44″				
Right asc. of Capella	72° 46′ 0″ *S.*				
Dist. from the merid.	20° 59′ 44″	Logar. 102638			
Declin. of Capella	45° 35′ 30″	Antil. 35701 *A.*	Declin. Logar. 33635		
	Perpend. E F	Logar. 138339	14° 31′ 14″	Antil. 3246 *S.*	
	Antil. of the latit. *	128779 *S.*		S F Antil. 30389	42° 26′ 40″
Azim. of Capel. west	65° 20′ 40″	Logar. 9560		Compl. of the elev. of the pole A S	35° 37′ 0″
Azim. of the comet	79° 36′ 0″			A F Antil. 712	6° 49′ 40″A F
Angle C A E	14° 15′ 20″	Logar. 140142		E F Antil. 3246	
Compl. of the altit. of Capel.	36° 0′ 52″	Logar. 87427 *A.*		E K Logar. 3958	73° 59′ 8″Altit.
		Logar. 227569			of Capel.
Dist. of the com. and Cap.	22° 54′ 19″	Logar. 94363 *S.*			
		Logar. 133206	Ang. E C D or I C[?] G	15° 18′ 13″	

397

[396]set as above. The marks are printed after 48 30 and 48 22, and as column heads over 0 3 38; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 48 30, 48 22 or 5 35. The 0 before 3 38 is printed. The tags *A.* and *S.* are the page's own. The page prints 0.055 where 9.952 less 9.892 gives 0.060, and names E L for 22° 54′ 19″, the distance it calls the later distance E I elsewhere; both are kept as printed.

[397]set as above. The marks are printed after 93 45 44, 14 31 14 and 15 18 13, and as column heads over 42 26 40; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the star sign * are the page's own; the tag "Altit. Capel." runs down the right edge across two rows, as printed.

2. For the reduction to the vertical.

Mesol. of the side C G, or parall. of the orbit	5′ 35″	642278	
Antil. of the angle E C D	15° 18′ 13″	3611 *S.*	
Mesol. of the parall. reduced to the vertical C I		638667	5′ 47″.

398

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*

With this found, then, let the prosthaphaereses of inclination likewise be determined in Figure Z; in this place they will be subtractive, according to axiom 3.

For the altitude and azimuth of Capella, and also the angle B A C, at $5^h\ 40^m\ 48^s$.

Right asc. of the midheaven	362° 33′ 12″				
Right asc. of Capella	72° 46′ 0″				
Distance from the merid.	70° 12′ 48″	Log. 6085	Compl. to 360°		
Declin. of Capella	45° 35′ 30″	Ant. 35701 *A.*	Declinat. Log. 33635		
	Perpend. B V	Log. 41786	41° 10′ 52″	Ant. 28417 *S.*	
Logarithm 41786 perp. B V			S V 18° 20′ 54″	Ant. 5218	
Antil. of the altit. 36339 *S.*			S A 35° 37′ 0″		
Log. of the azim. 5447	71° 15′ 36″		V A 17° 16′ 6″	Ant. 4612	
			B V	Ant. 28417 *A.*	
Compl. of the altit. of the comet	36° 26′ 30″	Logar. 52086	B K	Log. 33029	45° 56′ 52″ altit.
Compl. of the altit. of Capell.	44° 3′ 8″	Logar. 36339 *A.*		Altitud. of the com.	53° 53′ 30″ of Cap.
Difference	7° 36′ 38″	Logar. 88425		Different. of alt.	7° 36′ 38″

399

398 set as above. The marks are printed after 5 35 and 5 47; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 5 35 or 5 47. The tag *S.* is the page's own.

399 set as above. The marks are printed after 362 33 12, 360, 41 10 52 and 45 56 52, and as column heads over 71 15 36; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own; the tag "altit. Cap." runs down the right edge across two rows, as printed. The page prints the comet's altitude as 53° 53′ 30″, where the complement in the first column (36° 26′ 30″) and the difference printed beside it (7° 36′ 38″) answer to 53° 33′ 30″; the printed figure is kept.

Distant. of the comet and Capell.	22° 45′ 55″		
Sum	30° 22′ 32″		
Half	15° 11′ 16″	Logar. 133946	
Difference	15° 9′ 17″		
Half	7° 34′ 38″	Logar. 202598 *A.*	
	Later aggregate	336544	
	Earlier aggregate	88425 *S.*	
		284119	
	Half-angle, logar.	124059	16° 48′ 39″
	Whole angle B A C sought		33° 37′ 18″

400

Diagram. An engraved figure across the page in a plate-mark frame, of three diagrams side by side. At the left, X: a tall spherical triangle with its apex at A, the arc marked "Orbita Cometæ." *Orbit of the comet* running down the right side, the star Capella at E on the left, and the ecliptic along the base. In the middle, Y: a circle cut by the horizon, the comet's orbit, the equator and the ecliptic, with Capella at E and C at a small circle on the comet's orbit, marked "Occidens." and dated to $11^h\ 44^m\ 31^s$ in the evening. At the right, Z: a circle with the same lines, Capella at B and C at a small circle, marked "Oriens." and dated to $5^h\ 40^m\ 48^s$ in the evening. The engraver's signature stands at the lower right. Labels as printed, from the top down:

- X: A (apex); "Orbita Cometæ." *Orbit of the comet* (set vertically along the arc at the right); M; I (at a small circle); L (at a small circle); "Capella" and E (at a star, left); F; X (centre); "Ecliptica." *Ecliptic* (along the base arc); G, H, C, B (along the base).
- Y: F, A (top); [?] (an engraved sort at the upper left, outside the circle, not resolved to a letter); "Cap. E" (at a star); D; I; S (upper right); P, T (left); C (at a small circle on the orbit); "Orbita Cometæ." *Orbit of the comet*; R (right end of the orbit); M (left end of the horizon); "Horizon." *Horizon*; L (right end of the horizon); K, O (below the horizon); "Occidens." *West*; Y; "Æquator." *Equator*; "Ecliptica." *Ecliptic*; N (end of the ecliptic, lower right); "Hor. II 44′ 31″ v." *At $11^h\ 44^m\ 31^s$ in the evening* (under the circle).
- Z: R, A (top); V, S (upper left); E; "Capella." and B (at a star); C (at a small circle); H; D; W; M (left end of the horizon); "Horizon." *Horizon*; L (right end of the horizon); T, O (below the horizon); K; "Ecliptica." *Ecliptic*; "Æquator." *Equator*; "Oriens." *East*; Z; "Orbita Cometæ." *Orbit*

400 set unruled, in the page's own columns, continuing the calculation of the previous page. The marks are printed after 22 45 55 and 16 48 39; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own. The page prints the sum as 30° 22′ 32″, where 22° 45′ 55″ and the difference of altitudes on the previous page (7° 36′ 38″) give 30° 22′ 33″; and it prints 284119 for the difference of the two aggregates, where 336544 less 88425 gives 248119, whose half is the 124059 printed below it. Both printed figures are kept.

of the comet (set vertically); X (end of the orbit, lower right); "Hor. 5 40′ 48″ v." *At 5^h 40^m 48^s in the evening* (under the circle); "Autor fculps." *The author engraved it* (lower right).[401]

Inquiry into the angles A B C, A B D and C B D of inclination of the parallax for the first equat., and also into its prosthaph. Subt.

Angle B A C	33° 37′ 18″	Logar. 59112			
Compl. of the altit. of the com.	36° 26′ 30″	Logar. 52086 *A.*			
	Sum	Logar. 111198			
Dist. of the com. and Capell.	22° 45′ 55″	Logar. 94942 *S.*			
		Logar. 16256	58° 12′ 27″ A B C angle		
Angle B A C	33° 37′ 18″	Logar. 59112			
Compl. of the altit. of Capell.	44° 3′ 8″	Logar. 36339 *A.*		Ant. 33022	
Perpendic. D E		Logar. 95451	22° 38′ 0″	Ant. 8014 *S.*	
Side E B	5° 12′ 0″	Logar. 240004 + *S. Cos.*		Ant. 25008	38° 51′ A E
Perpend. D E	22° 38′ 0″	Mesol. 87481 +			44° 3′ A B
Angle D B A		Mesol. 152523 —	77° 43′ 32″ D B A 58° 12′ 27″ A B C		5° 12′ E B
Parall. reduced to the vertic.	5′ 47″	Logar. 638667	19° 31′ 5″ D B C		
Angle of inclination	19° 31′ 5″	Logar. 109630 *A.*			
Prosth. of the inclinat. of the first equat. C W		Logar. 748297	1′ 56″ *S.*		
	Parallax reduced to the vertical was		5′ 47″		
	Parallax equated a first time		3′ 51″		

402

[Margin: Parallaxis primò coæquata.] *The parallax equated a first time.*

[401] every label on the plate is listed; one, at the upper left of Y, is not resolved. The point G that the previous page cites for diagram Y (the angle I C G and the side C G) is not identified on the plate.

[402] set unruled, in the page's own columns. The marks are printed after 33 37 18 and 58 12 27, and as column heads over 77 43 32, over 38 51 and over 1 56; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 5 47, 1 56 or 3 51. The 0 seconds after 5 12 and 22 38 are printed. The tags *A.*, *S.* and *S. Cos.*, the sign +, and the long stroke after 152523 are the page's own.

For the prosthaph. of the inclinat. B D of the second equat. Subtr.

Dist. C B of the com. and Capell.		22° 45′ 55″	Log. 94942 *S.*			
Perp. D E or B H		22° 38′ 0″	Log. 95451			
Angle B C D or B C H			Log. 509		B C D	84° 13′

403

Dist. C B of the com. and Capell.	22° 45′ 55″	Log. 94942			Mesol. 86827 + *S. Cosf.*	
Angle of inclin. D B C	19° 31′ 5″	Log. 109630 *A.*				
Perpend. C W		Log. 204572	C W 7° 26′ B C W		Mesol. 203662 + Antil. 116835 +	71° 53′
Prosth. of the inclin. of the first equat.	1′ 56″	Mes. 748297 +			B C D	84° 13′
Angle of inclin. W C D	12° 20′ 0″	Antil. 2335 + *S.*			Angle of inclin. W C D	12° 20′
Prosth. of the inclin. C D of the second equat.		Mes. 745962 +	1′ 59″	Subtr. in approach, above, etc.		
	Parall. reduced to the vertical		5′ 47″			
Therefore the genuine vertical parallax, equated a second time			3′ 49″	For the altitude of the comet		
51° 52′ 40″	at 11^{h} 44^{m} 31^{s}, observed on December 27.					

404

It is therefore plainly established that all the computations made for the parallaxes of the 27th agree with one another extremely well; so that, since one

[403] set as above. The marks are printed after 22 45 55 and after 84 13; the rest are supplied in the house form; no figure is supplied. The tag *S.* is the page's own.

[404] set unruled, in the page's own columns, continuing the calculation of the previous page. The marks are printed after 22 45 55, 7 26, 71 53, 1 59 and 51 52 40, and over the minutes and seconds of the hour; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 56, 1 59, 5 47 or 3 49. The tags *A.*, *S.* and *S. Cosf.*, the sign +, and the abbreviation Subtr. are the page's own. The page prints 3′ 49″ for the parallax equated a second time, where 5′ 47″ less 1′ 59″ gives 3′ 48″; the printed figure is kept.

parallax exceeds the other by scarcely a single minute, and more rarely by a little more, we may rightly rest content with this day. Now, for computing the parallaxes for December 28, there first present themselves to us the distances of the comet and Capella taken with the sextant: the earlier, parallel to the horizon, at $5^h\ 35^m\ 6^s$ in the evening on the 27th; the later, vertical, observed at $1^h\ 44^m\ 10^s$ in the morning on the 28th. Yet it is for this later one that the parallax is to be derived.

[Margin: Cùm omnes ſupputationes ritè inter ſe conveniant, neutiquam parallaxis in dubium vocari poteſt.] *Since all the computations agree properly with one another, the parallax can in no way be called into doubt.*

Investigation of Parallax XV, from the Distances of the Comet and Capella Observed with the Sextant, for December 28 [Inveſtigatio parall. XV. Ex Diſtantiis Cometæ & Capellæ Sextante obſervatis, ad diem 28 Decembr.]

1	Obs. at $5^h\ 35^m\ 6^s$ on the 27th, in the evening	Distance of the comet and Capell.	22° 48′	Parall.
2	Obs. at $1^h\ 44^m\ 10^s$ on the 28th, in the morning	Distance of the comet and Capell.	22° 52′	Vertical.
	Differ. $8^h\ 9^m\ 4^s$	Different.	4′	

405

1. Let the angle F L E be sought from the preceding figure Y; for the distance of Capella from the orbit has already been determined.

Earlier distant.	22° 48′ 0″	Logar. 94800	
Dist. of Capell. from the orbit E F	22° 50′ 32″	Logar. 94619 *S.*	
Angle F L E		Logar. 181	86° 33′ 0″

406

For the reduction and limitation of the earlier dist. E I.

[405] the time marks are printed only over the minutes and seconds of the first time, and the angle marks only after the first distance; the rest are supplied in the house form; no figure is supplied. The words Parall. and Vertical. stand at the right ends of the two lines, as printed.

[406] set unruled, in the page's own columns. The marks are printed after 22 48 0 and 86 33 0; the rest are supplied in the house form; no figure is supplied. The tag *S.* is the page's own. The page gives the distance of Capella from the orbit as 22° 50′ 32″ with the logarithm 94619, where the computation for December 27 two pages earlier gives 22° 50′ 37″ with the same logarithm; both are kept as printed.

Proper motion from the table	1° 5′ 13″	Log. 396693		Antilog. 17.995	
Angle F L E	86° 33′ 0″	Log. 181 *A.*			
Perpend. L M		Log. 396874	1° 4′ 57″	Antilog. 17.850 *S.*	
Antilog. E M 8064.486			I M	Antilog. 0.145	5′ 51″
Antilog. L M 17.850 *A.*			Distant. E I of Capell. and the com.		22° 48′ 0″
Antilog. L E 8082.336			22° 43′ 40″ E M		22° 42′ 9″
Later distant. was F I			22° 52′ 0″ Since, then, this later one is greater, there is therefore given		
Parallax of the orbit or reduct.			8′ 20″		

407

[Margin: Parallaxis orbitæ.] *Parallax of the orbit.*
For the reduction to the vertical, let there be computed
The altitude and azimuth of Capella, at 1^h 44^m 10^s.
The altitude and azimuth of the comet, at 1^h 44^m 10^s.

Right asc. of the Sun	277° 51′ 0″			
Elong. from the merid.	206° 2′ 30″ *A.*			
Right asc. of the midheaven	123° 53′ 30″	360° cast out	123° 53′ 30″	Right asc. of the midheaven.
Right asc. of Capella	72° 46′ 0″ *S.*		45° 48′ 20″	Right asc. of the comet.
Dist. from the merid.	51° 7′ 30″	Logar. 25036	78° 5′ 10″	Logar. 2179
Declin. of Capell.	45° 35′ 30″	Antil. 35701 *A.*	35° 14′ 0″	Antil. 20235 *A.*
E F	33° 0′ 37″	Logar. 60737	53° 3′ 0″	Logar. 22414

408

Log. declin. of Capell.	33635	Logar. 55007

[407] set as above. The marks are printed after 1 5 13 and 1 4 57, and as column heads over 22 43 40 and over 5 51; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 5 51 or 8 20. The tags *A.* and *S.* are the page's own. The clause "Quia igitur hæc poſter. major eſt, ergò datur" stands at the right of the printed line of the later distance and ends there, with no object printed after "datur".

[408] the two captions stand side by side over the two groups of figures, as printed. The marks are printed after 360 (as "gr.") and as column heads over the right-hand 123 53 30; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* are the page's own; the right-hand group sets its labels after its figures, as printed.

Antil. perpend. E F	17601 *S.*		Antil. 50896 *S.*		
Antilog. S F	16034	31° 36′ 50″	Antil. 4111	16° 19′ 0″	
Antilog.		35° 37′ 0″ S A		35° 37′ 0″	
A F	244	4° 0′ 10″ A F	Antil. 5683	19° 18′ 0″	
Antil. perpend. E F	17601		Antil. 50896 *A.*		
Log. altit. of Capell.	17845	56° 46′ 46″	Logar. 56579	34° 36′ 17″	Altit. of the com.
Log. of the perpendicular	60737		Logar. 22414		
Antil. altit. of Capell.	60171 *S.*		Antil. 19468 *S.*		
Log azimuth	566	83° 54′ 40″ *Occ.Sept.*	Logar. 2946	76° 9′ 30″	Azim. *Occ. Sept.*
Azimuth of the comet		76° 9′ 30″ *Occ.Sept.*			

409

Angle C A E	7° 45′ 10″	Logar. 200322		
Compl. of the altit. of Capell.	33° 13′ 14″	Logar. 60172 *A.*		
Perp. D E		Logar. 260494		
Dist. of the com. and Capel.	22° 52′ 0″	Logar. 94523 *S.*		
Angle E C D		Logar. 165971	10° 57′ 51″	Antil. 1842 *S.*
Mesolog. of the side C G, parall. of the orbit			8′ 20″	Mes. 602231
Parall. reduced to the vertical			8′ 29″	Mes. 600389

410

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*
For deriving the prosthaphaereses of inclination.
Altitude and azim. of Capell. at 5^h 35^m 6^s.
Altitud. and azim. of the com. at 5^h 35^m 6^s.

Right asc. of the Sun	277° 21′ 0″
Elong. from the merid.	83° 46′ 30″ *A.*

[409] set unruled, in the page's own two groups, Capella at the left and the comet at the right, continuing the calculation of the previous page for 1^h 44^m 10^s. The marks are printed as column heads over 31 36 50 and over 16 19 0; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.*, the point-letters and the direction tags *Occ.Sept.* are the page's own; the second "Sept." of the right group stands on the line below "Azim.Occ.", as printed.

[410] set as above. The marks are printed as column heads over 10 57 51; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 8 20 or 8 29.

Right asc. of the midheaven	1° 7′ 30″	360° cast out	1° 7′ 30″	Right asc. C.
Right asc. of Capell.	72° 46′ 0″		46° 48′ 0″	Right asc. of the com.
Dist. from the merid.	71° 38′ 30″	Logar. 5228	45° 40′ 30″	Logar. 33507
Declinat. of Capell.	45° 35′ 30″	Antil. 35701 *A.*	34° 26′ 0″	Antil. 19263 *A.*
B V	41° 37′ 0″	Logar. 40929	36° 9′ 14″	Logar. 52770
Logar. declin.	33635		Logar. 57014	
Antil. perp.	29088 *S.*		Antil. 21384 *S.*	
Antil. S V	4547	17° 9′ *S.*	Antil. 35630	45° 33′
S A		35° 37′		35° 37′
V A		18° 28′		9° 56′
Antil. V A	5286		1361	
Antil. B V	29088 *A.*		21384 *A.*	
Logar. B K	34374	45° 9′ 44″ Altit. of Capell.	22745	52° 48′ 10″ alt. of the com. 45° 9′ 44″ altit. of Cap.
Logar. perpend.	40929		Log. perp. 52770	7° 38′ 26″ Diff. of altit.
Antil. altit.	34949 *S.*		Antil. alt. 50325 *S.*	
Log. azim.	5980	70° 23′ Azim. of Cap. *Or.S.* 77° 23′ Azim. of the com. *Or.M.*	Log. azim. 2445	77° 23′ azimuth of the com. *Or.M.*
Sum		147° 46′		
Compl. to 180′, angle		32° 14′ B A C.		

411

[Margin: Figura Z.] *Figure Z.*

Inquiry into the angles C B A, A B D and C B D of inclination, and also into the prosthaph. of the first equat. Subt., by axiom 3.

Angle B A C	32° 14′ 0″	Log. 62854
Compl. of the alt. of the com.	37° 11′ 50″	Log. 50316 *A.*

411 the two captions stand side by side over the two groups of figures, as printed. The marks are printed after 360 (as "gr."), over the right-hand 1 7 30, over 17 9 and 45 33, over 45 9 44 and 52 48 10, and over 70 23 and the right-hand 77 23; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.*, the point-letters and the direction tags *Or.S.* and *Or.M.* are the page's own; the right-hand group sets its labels after its figures, and the second line of its azimuth label stands below, as printed. The right-hand label of 1° 7′ 30″ is printed "Afc. R. C.", without the M. of the left-hand label. The last label prints a minute mark after 180, where the subtraction is from 180 degrees (180° less 147° 46′ gives the 32° 14′ printed); the printed mark is kept.

		Log 113170			
Dist. of the com. and Capell.	22° 48′ 0″	Log. 94800 *S.*			
Angle A B C		Log. 18370	56° 19′ 27″ A B C		
Angle B A C	32° 14′ 0″	Log. 62854			
Compl. of the alt. of Capell.	44° 50′ 16″	Log. 34949 *A.*		Antil. 34359	
Perpend. D E		Log. 97803	22° 5′ 21″	Antil. 7623 *S.*	
				Antil. 26736	40° 2′ 28″ A E

412

Side E B	4° 47′ 48″	Log. 248147 + *S.Cosf.*			40° 2′ 28″ A E
Perpendic. D E	22° 5′ 21″	Mes. 90180 +			44° 50′ 16″ A B
		Mes. 157967 —	78° 28′ 27″ D B A		4° 47′ 48″ E B
			56° 19′ 27″ A B C		
		Log. 97542 *A.*	22° 9′ 0″ D B C	Angle of inclinat.	
Parall. reduced to the vertic.	8′ 29″	Log. 600390			
		Log. 697932 C W	3′ 12″	Prosth. of the first equat. Subt.	
	Parall. reduced to the vertical		8′ 29″		
	Vertic. parall. equated a first time		5′ 17″		

413

[Margin: Parallaxis verticalis primò coæquata.] *The vertical parallax equated a first time.*

412 set as above. The marks are printed after the first 32 14 0, and as column heads over 56 19 27 and over 40 2 28; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the point-letters are the page's own.

413 set unruled, in the page's own columns, continuing the calculation of the previous page. The marks are printed after 4 47 48, 40 2 28 and 8 29, and as column heads over 78 28 27; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 8 29, 3 12 or 5 17. The tags *A.* and *S.Cosf.*, the sign +, the long dash after 157967, the point-letters and the abbreviation Subt. are the page's own. The page gives the logarithm of the reduced parallax 8′ 29″ as 600390, where the previous page ends its computation of the same parallax at Mes. 600389; both are kept as printed.

For the prosthaphaeresis B D of the second equat. Subt.

Dist. C B of the com. and Capell.	22° 48′ 0″	Log. 94800 *S.*			
Perpend. D E or B H	22° 5′ 21″	Log. 97803			
Angle B C D or B C H		Log. 3003	76° 2′ B C D		
Dist. C B, dist. of the com. and Cap.	22° 48′ 0″	Log. 94800		Mesol. 86664 + *S. Cos.*	
Angle of inclin. D B C	22° 9′ 0″	Log. 97542 *A.*			
Perpendic. C W		Log. 192342	8° 24′	Mesol. 191279 +	
Prosth. of the inclin. of the first equat. C W	3′ 12″	Mes. 697932 +	B C W	Antil. 104615 +	69° 26″
				B C D	76° 2′
Angle W C D	6° 36′ 0″	Ant. 665 + *S.*		Angle of inclin. sought W C D	6° 36′
Prosth. of the inclin. of the second equat. C D		Mes. 697267 +	3′ 13″		
	Parallax reduced to the vertical		8′ 29″		
	Genuine vertical parallax, equated a second time		5′ 16″	For the altitude of the comet	
34° 36′ 17″	at 1^h 44^m 10^s, observed on December 28.				

414

For a further inquiry into the parallax of this day, the 28th, we shall keep, in the following calculation, that earlier observed distance at 1^h 44^m 10^s, and add to it a new observation, made on the 29th at 4^h 10^m 50^s, likewise obtained with the sextant. We shall labour so that the parallax can equally be derived accurately from observations of this kind, made on different days. It should, however, be carefully noted that these observations are very different from all the others that have served us so far. For the said distances were both observed in one and the same western quadrant, whereas until now we have always

414 set as above. The marks are printed after the first 22 48 0, after 3 13 and 34 36 17, and over the minutes and seconds of the hour; as column heads over 76 2, and over 69 26 as a degree circle and a double stroke, which the 69° 26″ keeps; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 3 12, 3 13, 8 29 or 5 16. The subtraction of 69 26 from 76 2, giving the 6 36 printed, takes the 26 as minutes. The tags *A.*, *S.* and *S. Cos.*, the sign + and the point-letters are the page's own; 8 24 is set without marks and is taken as degrees and minutes, the column's form.

chosen for our parallactic computation one taken in the eastern region and the other in the western, or the reverse. In addition, both distances also lay on the same vertical circle, and neither of them was parallel to the horizon. This is certainly worth noting. For in the earlier observation the comet stood 34° above the horizon, but in the later only 16°, and so it was subject to refractions. It is therefore of the greatest importance that the later distance be freed entirely of all refraction, by means of the small table that follows.

[Margin: Ex duabus diſtantiis, in uno eodemq́; quadrante obſervatis ſubducere parallaxin.] *To compute the parallax from two distances observed in one and the same quadrant.*

[Margin: Refractio hic adhibenda.] *Refraction is to be applied here.*

And since every refraction raises any phenomenon whatever, it is necessarily always subtracted from the altitude. Here, however, since Capella stood at a right angle with respect to the comet and its orbit, and also above the comet in that same later observation, the refraction diminished that distance by raising the comet toward Capella; so here the refraction must be added to the distance. But if the comet had stood above the fixed star, the refraction would necessarily have had to be subtracted, and I urge you to keep this in mind again and again.

[Margin: Omnis refractio phænomenon attollit.] *Every refraction raises the phenomenon.*

On the refractions to be applied to comets, I would have you know this: that one refraction belongs to the Sun, the Moon and the planets, and another in turn to the fixed stars (as there is no student of the stars who has not established it). Accordingly I consider it most fitting, in my judgement, that comets too should have refractions of their own applied to them. For the bodies of comets are, for the most part, smaller in appearance than the bodies of the luminaries, and yet again they are found to be larger than even the fixed stars of the first magnitude; moreover, they move more often in the region of the planets, that is, above the Moon and below the fixed stars. For this reason I thought I would not be acting wrongly if I took a middle course, and set for the comets refractions a little smaller than the Moon's and, again, a little larger than those of the fixed stars: such as I now present in the small table attached.

[Margin: Quales refractiones adhibendæ ſint Cometis.] *What refractions are to be applied to comets.*

Small Table of the Refractions of Comets.

Altit. of the com.	Mi. Se.	Altit. of the com.	Mi. Se.
Horiz.	31′ 0″	16	5′ 30″
1	23′ 0″	17	5′ 0″
2	18′ 0″	18	4′ 30″
3	15′ 0″	19	4′ 0″
4	13′ 20″	20	3′ 30″
5	12′ 20″	21	3′ 0″
6	11′ 50″	22	2′ 35″
7	10′ 45″	23	2′ 10″

Altit. of the com.	Mi. Se.	Altit. of the com.	Mi. Se.
8	10′ 0″	24	1′ 45″
9	9′ 20″	25	1′ 20″
10	8′ 45″	26	1′ 0″
11	8′ 10″	27	0′ 40″
12	7′ 35″	28	0′ 20″
13	7′ 0″	29	0′ 10″
14	6′ 30″	30	0′ 0″
15	6′ 0″	31	0′ 0″

415

Investigation of Parallax XVI, from the Distances of the Comet and Capella Taken with the Sextant, for December 28 [Inveſtigatio Parallaxeos XVI. Ex diſtantiis Cometæ & Capellæ Sext. captis, ad diem 28 Decembr.]

1.	Observ. at $1^h\ 44^m\ 10^s$ *m.*	on December 28	Distance of the comet and Capell.	22° 52′ 0″ in the west.
2,	Observ. at $4^h\ 10^m\ 50^s$ *m.*	on December 29	Distance of the comet and Capell.	22° 46′ 0″
	Differ. $26^h\ 26^m\ 40^s$		Refraction at about 14° or 15° of alt.	6′ 30″
			Later distance corrected	22° 52′ 30″
			Difference of the earlier and the later corr. distances	30″

416

[Margin: Differentia diſtantiarum nonnunquam genuinam parallaxin illicò detegit.] *The difference of the distances sometimes reveals the genuine parallax at once.*

Now if the comet had exercised no proper motion at all, and both observations had been vertical, the difference of the distances between about 34

415a ruled table in a frame, its caption inside the frame (Tabella Refract. Comet.). Two pairs of columns, divided by a double rule; each altitude column is headed Altit. Comet. and each refraction column Mi.Se., minutes and seconds. The cells print the figures only; the altitudes are kept as printed, and the minute and second marks are supplied in the house form under the printed head; no figure is supplied. Rules divide the rows in groups of three. No labels stand at the foot of the table.

416set unruled, in the page's own columns, the observation figures 1 and 2 at the head of their lines, the second followed by a comma, as printed. The time marks are printed only over the first time, with no hour mark, and the angle marks only over the first distance; the rest are supplied in the house form; no figure is supplied. The 6 30 stands under the minutes and seconds of the distance above it, and the 30 under its seconds. The abbreviation *m.* after each time is never expanded on the page and is kept as printed.

and 16 degrees of the comet's altitude would be the genuine difference of the parallaxes. However, since $26^h\ 26^m\ 40^s$ elapsed between the two observations, and the comet possesses a proper motion, the later distance was corrupted; and so that motion must of necessity first be entirely eliminated from the distances. Next we shall also try to derive the parallax by reducing one distance to the vertical and the other to the parallel of the horizon. And finally, from the same observations, we shall endeavour to investigate the genuine difference of parallax by a method entirely unknown before now.

[Margin: Methodo hucusq; incognitâ parallaxeos differentiam invenire.] *To find the difference of parallax by a method unknown until now.*

For the reduction of the earlier distance E I.

Later dist.	22° 52′ 30″	Logar. 94487 *S.*			
Dist. from the orbit	22° 50′ 32″	Logar. 94619			
Angle		Logar. 132	87° 3′ 30″ F I E		
Proper motion from the tab.	2° 56′ 6″	Logar. 297196 *A.*		Antil. 131.257	
Perpend. L M		Logar. 297328	2° 55′ 52″	Antil. 130.911 *S.*	
Antil. E M	8079.705		I M	Antil. 0.346	9′ 6″
Antil. L M	130.911 *A.*			Dist. E I of the com. and Cap., later	22° 52′ 30″
Antil. L E	8210.616	22° 54′ 6″ or E I corr.		E M	22° 43′ 24″
Distance E L, the earlier, was		22° 52′ 0″			
Differ. of the dist., or fictitious parall.		2′ 6″			

417

[Margin: Parallaxis ficta.] *The fictitious parallax.*

This fictitious parallax must now be brought back to the vertical, since E I, the later distance, is greater than the earlier, E L, so that, according to axiom 5, a parallax really is present in the observations. This can easily be done, since the angle E C D, namely of the comet's vertical and of the distance of the comet and Capella at the given hour, $1^h\ 44^m\ 10^s$, is already known from the preceding calculation.

Diagram. An engraved figure in a plate frame, set at the left beside the opening paragraph and lettered AA: a circle crossed by great-circle arcs and straight lines, with dotted lines running from F to the star at B and from B

[417] set unruled, in the page's own columns. The marks are printed after 22 52 30 (first row), 87 3 30, 2 55 52, 9 6 and 22 54 6; the rest are supplied in the house form; no figure is supplied. The 2 56 6 stands in the column of the degree figures above it, and the 2 6 under the minutes and seconds of 22 54 6. The tags *A.* and *S.* and the point-letters are the page's own; the caption names E I, and the second-to-last row names E L, as printed.

and I towards V. The arcs are named in script as the ecliptic, the equator, the horizon and the orbit of the comet; the star at B is named as Capella; the word for the west stands inside the circle below the orbit. Under the circle the hour is engraved, and at the lower right the engraver's line. No letter G stands on the figure, although the calculation below names the side C G.

- A (top of the circle)
- F, S, R, V, L (right side of the circle, top to bottom)
- N (lower right, on the circle)
- O, K (inside, near the line from M to L); Y (inside, below K)
- X (left, on the circle); M (left end of the horizon line); P (upper left)
- [?] (upper left above P, where the ecliptic arc begins: a sign of two joined curls, not identified)
- B (the star marked Capella); H, D, I (left of and below B); E (above C); C (the small circle where several lines meet)
- Ecliptica. (along an arc): *The ecliptic.*
- Æquator. (along an arc): *The equator.*
- Capella. (beside B, with a stroke to the star): *Capella.*
- Horizon. (along the line from M): *The horizon.*
- Orbita Comet. (along the line from X): *The orbit of the comet.*
- Occidens (inside, below the orbit): *The west.*
- AA (inside, lower left of centre): the figure's letter
- Hor.4 10′ 50″.m. (under the circle): *At 4^h 10^m 50^s, m.*
- Autor ſculps. (lower right inside the frame): *Engraved by the author.*

Mesol. of the side C G	2′ 6″	parall. of the orbit 740064	
Ant. of the angle D C E	10° 57′ 51″	1842 *S.*	
Mesol. of the parallax reduced to the vertic.		738222	2′ 8″

418

For the prosthaphaeresis of inclination, however, let us first investigate, namely for the 29th at 4^h 10^m 50^s in the morning, both the altitudes of the comet and of Capella and their azimuths, together with the angle B A C.

Altit. of Capella, for d. 29 at 4^h 10^m 50^s.

Altit. of the comet, for d. 29 at 4^h 10^m 50^s.

Right asc. of the Sun	278° 57′ 0″
Elong. from the merid.	242° 42′ 30″
	A.

[418] set unruled, in the page's own columns. The marks are printed after 2 6 and 2 8; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 6 or 2 8. The tag *S.* is the page's own.

Right asc. of the midheaven	161° 39′ 30″	360 degrees cast off		161° 39′ 30″	Right asc. of the midheaven	
Right asc. of Capell	72° 46′ 0″			43° 47′ 28″	Right asc. of the comet.	
Dist. from the merid.	88° 53′ 30″	Logar. 19			Diff. compl. to 180°; dist. from the mer.	
Declin. of Capell.	4[?]° 35′ 30″	Antil. 35701 *A.*		62° 7′ 58″	Log. 12325	
Perpend. B F	44° 22′ 50″	Logar. 35720		37° 35′ 50″	Ant. 23280 *A.*	
			C V	44° 27′ 44″	Log. 35605	
Log. declin.	33635		Log. declin.	49414		
Ant. perp. B F	33618 *S.*	Antil. 33618	Ant. perp. C V	33729 *S.*		Ant. 33729
Antil. S F	17	1° 4′	Antilogar. S V	15685	31° 15′ 30″	
S A		35° 37′	S A		35° 37′ 0″	
A F		34° 33′ Antil. 19403 *A.*	A V		66° 52′ 30″	Ant. 93427
Altitud. of Capella		36° 3′ Log. 53021	Altit. of the comet		16° 17′ 0″	Log. 127156
			Altit. of Capell.		36° 3′ 0″	
Log. perp.	35720		Diff. of altitud.		19° 46′ 0″	
Ant. altit.	21257 *S.*		Log. perp. C V		35605	
Log. azim.	14463	59° 55′ 17″ Azim. of Capell. *Occ.S.*	Ant. altit.		4085 *S.*	
		46° 51′ 22″ Azim. of the com. *Occ. S.*	Log. azim.		31520	46° 51′ 22″ azim. of the com.
Angle B A C		13° 3′ 55″				

419

[419] the two captions stand side by side over the two groups of figures, as printed. Set unruled, in the page's own groups, Capella at the left and the comet at the right; the right-hand group sets the labels of its first rows after its figures, as printed. The marks are printed after 278 57 0, after 1 4, after 180, and as column heads over the right-hand 161 39 30, over 31 15 30, over 59 55 17 and over the right-hand 46 51 22; the rest are supplied in the house form; no figure is supplied. The first figure of the declination of Capella is only partly inked in its second sort and is carried with a query. The tags *A.* and *S.*, the point-letters and the direction tags *Occ.S.* and *Occ. S.* are the page's own; the second line of the right-hand azimuth label stands below, as printed.

[Margin: Azimuth Capellæ & Cometæ.] *The azimuths of Capella and of the comet.*

Inquiry into the angles A C B, A C D and B C D of inclination, and also into the prosthaph. of the first equat., likewise Add.

Angle B A C	13° 3′ 55″	Logar. 148695	
Compl. of the altit. of Capell.	53° 57′ 0″	Logar. 21257 *A.* Logar 169952	
Dist. of the com. and Capell.	22° 52′ 30″	Logar. 94487 *S.*	
Angle B C A		Logar. 75465	28° 2′ 44″

420

Angle B A C	13° 3′ 55″	Logar. 148695			
Compl. of the altit. of the com.	73° 43′ 0″	Logar. 4094 *A.*		Ant. 127158	
Perpendic. D E		Logar. 152789	12° 31′ 56″	Ant. 2411 *S.*	
Side E C	24′ 51″	Logar. 492972 + *S. Cofs.*		Ant. 124717	73° 18′ 9″ A E
Perpend. D E	12° 31′ 56″	Mesol. 150379 +			73° 43′ 0″ A C
Angle D C A		Mesol. 342593 —	88° 8′ 15″ D C A		24′ 51″ E C
			28° 2′ 44″ B C A		
Angle of inclination		Logar. 14291	60° 5′ 31″ D C B		
Parall. reduced to the vertic.	2′ 8″	Logar. 738222 *A.*			
Prosth. of the inclinat. of the first equat. B I		Logar. 752513	1′ 51″ *A.*		
	The parallax reduced to the vertical was		2′ 8″		
	Parallax equated a first time		3′ 59″		

[420] set as above. The marks are printed after the first 13 3 55 and after 28 2 44; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the point-letters are the page's own.

421

[Margin: Parallaxis primò coæquata.] *The parallax equated a first time.*
For the genuine prosthaph. B D of the second equat. Add.

Dist. C B of the com. and Capell.	22° 52′ 30″	Log. 94487 *S.*			
Perp. D E, or B H	12° 31′ 56″	Log. 152789			
Angle H B C or D B C		Log. 58302	56° 4′ D B C		
Dist. C B of the com. and Capell.	22° 52′ 30″	Log. 94487		Mesol. 86339 + *S. Cosf.*	
Angle of inclin. D C B	60° 5′ 31″	Log. 14291 *A.*			
Perpend. B I		Log. 108778	19° 42′	Mesol. 102708 +	
				Antil. 16369 +	31° 54′ C B I
Prosth. of the inclin. of the first equat. B I	1′ 51″	Mes. 752513 +			56° 4′ D B C
Angle of inclin. I B D	24° 10′ 0″	Antil. 9172 + *S.*		Angle of inclin.	24° 10′ I B D
Prosth. of the second equat. B D		Mes. 743341 +	2′ 2″ *A.*		
	Parall. reduced to the vertical		2′ 8″		
	Therefore the genuine vertical parallax, equated a second time		4′ 10″	For the altitude of the comet	
34° 36′ 17″	observed on December 28 at $1^h\ 44^m\ 10^s$ *m.*				

422

This parallax agrees very well with the one derived from the preceding calculation: the difference is scarcely one minute, even though it was derived from very different observations, and likewise by a different method. But the two would agree still better if the comet had not been subject to refractions in

[421] set unruled, in the page's own columns, continuing the calculation of the angles begun on the previous page. The marks are printed after 13 3 55, after the middle 12 31 56 and after the left 2 8, and as column heads over 73 18 9, over 88 8 15 and over 1 51; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 24 51, 2 8, 1 51 or 3 59. The tags *A.*, *S.* and *S. Cosf.*, the sign +, the long dash after 342593 and the point-letters are the page's own. The page prints the antilogarithm of A E as 124717, where 127158 less 2411 gives 124747; all three are kept as printed.

[422] set as above. The marks are printed after both 22 52 30, after 56 4, 19 42, 31 54, 2 2 and 34 36 17, and over the minutes and seconds of the hour; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 51, 2 2, 2 8 or 4 10. The tags *A.*, *S.* and *S. Cosf.*, the sign + and the point-letters are the page's own; the abbreviation *m.* after the time is kept as printed.

the later observation; above all, if we had applied to it Tycho's refraction of the Moon, 7′, the parallax would then have come out at 5½′. So there should now be no doubt at all about this parallax on the 28th.

[Margin: Hæc parallaxis haud malè cum priore convenit.] *This parallax agrees not badly with the earlier one.*

It remains for us now also to show, as we promised at the beginning, how the difference of the parallaxes ought to be computed from observations of this kind: namely, when in both observations the angle B C A, with the comet standing below the fixed star (or, with it above the fixed star, the angle B C D), does not exceed 30 or 40 degrees.

[Margin: Ex quibus obſervationibus differentia tantùm parallaxeos inveſtigari poſſit.] *From which observations only the difference of parallax can be investigated.*

Having found this angle B C A of the later observation, then, let its antilogarithm be subtracted from the mesol. of the side C G of the fictitious parall.; at once there results the mesol. of the parall. reduced to the vertical for the later observation. Take this away from the parallax reduced to the vertical for the earlier observation, and you will have the difference of the parallaxes itself. It is better, however, if the observations permit it, to compute the parallax for a definite altitude, as has also been done by us until now. But when you have observed both distances almost at the same time, or the one shortly after the other, and that in the same quadrant, where the angle B C A or B C D is very acute, so that impos- sible to investigate the parallax for a definite altitude; then, I say, one must proceed by the way shown here, by which the difference of the parallaxes may become evident. For example:

Mesol. of the side C G of the fict. parall.	2′ 6″	740064	
Antil. of the angle B C A	28° 2′ 44″	12493	
		S.	
Mesol. of the parall. reduced to the vertical, later observ.		727571	2′ 23″
The earlier parall. reduced to the vertical was			2′ 8″
Therefore the diff. of the parall. between 34 and 16 deg. of altit. of the com.			15″ is only; if you add it
to the parallax equated a second time,			4′ 10″ there results the genuine parallax
for the altit. of the other observation,			4′ 25″ namely 16 deg. 17 min.:

423

[Margin: Genuina Parallaxis.] *The genuine parallax.*

[423] set unruled, in the page's own columns; the last three rows are one sentence, its words running on after the figures to the end of each line, as printed. The marks are printed after 2 6 and 2 23 only; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 6, 2 23, 2 8, 15, 4 10 or 4 25. The tag *S.* and the point-letters are the page's own.

since this altitude is lower than the earlier one. Otherwise, if the later altitude is greater than the earlier, let it be subtracted from that same parallax.

This difference of the parallaxes ought, indeed, to have been a little greater, by about 15 seconds. But this arises only from an angle that is too large; had the angle been somewhat smaller, the difference of the altitudes would also have come out more correct. Meanwhile, however, anyone skilled in these matters will marvel with me that, by keeping to this method, we can still derive the vertical parallaxes themselves for each observation so exquisitely that only a very few seconds are lacking.

[Margin: Quòd etiam hâc viâ æq̃; accuratè parallaxis erui posſit, meritò admiramur.] *That the parallax can be derived just as accurately by this way too, we rightly admire.*

Now that we have investigated the parallax for the 28th, let us therefore go further and inquire into it likewise for December 29, although very few observations were made on that day from which this could conveniently be done. We shall nevertheless take pains that this task can be accomplished in the following calculation, by means of the observed distances of the comet and Capella. We shall keep the later observation, namely the preceding one, of the 29th at $4^h\ 10^m\ 50^s$ in the morning, with the fixed star and the comet standing under the same vertical; and we shall add to it another, a parallel distance observed on the 30th at $6^h\ 41^m\ 50^s$ in the evening, since it did not happen that two could be taken together on that same day, the 29th. Since, however, in the earlier observation, on the 29th, the comet was quite near the horizon, the distance must first be corrected for refraction, and then the difference of the distances must be limited by the true proper motion. For this limitation the distance of Capella from the orbit of the comet is required, to be computed again from Figure X. For since both the angle of the orbit and the ecliptic and the point of intersection are now beginning to vary noticeably from day to day, the distance of Capella found above can be of no further use to this calculation.

[Margin: Ex quibus obſervationibus parallaxes ad diem 29 Dec. ſupputari debeant.] *From which observations the parallaxes for December 29 are to be computed.*

Investigation of Parallax XVII, from the Distances of the Comet and Capella Observed on December 29 and 30 [Inveſtigatio Parallaxeos XVII. Ex diſtantiis Cometæ & Capellæ obſervatis, die 29 & 30 Decemb.]

1.	Observ. on d. 29 at $4^h\ 10^m\ 50^s$ *m.*	Distance of the com. and Capella	22° 46′ 0″
	Since the star is higher than the comet, refraction add.		6′ 30″
		Distance corrected	22° 52′ 30″ E L
2.	Observ. on d. 30 at $6^h\ 41^m\ 50^s$ *vesp.*	Distance of the com. and Capella	23° 27′ 0″ E I

Differ. of the hours $38^h\ 31^m\ 0^s$		Difference of the distances	35′ 0″	
424				
Long. of Capella	17° 0′ 12″ ♊			
Point of intersect. of the eclipt.	28° 32′ 0″ ♉	for December 29		
Differ. G H	18° 28′ 12″	Antil. 5288		
Latitude of Capella	22° 52′ 15″	Antil. 8188 *A.*	Latitud.	Log. 94505
	Hyp. H E	Antil. 13476	29° 4′ 17″	Log 72175 *S.*
		Angle G H E	53° 7′ 5″	Log. 22330
425				
Angle G H E	53° 7′ 5″ *S.*			
Compl. to 180°, of the angle of the orb. and the eclipt.	106° 1′ 0″			
There remains the angle E H F	52° 53′ 55″	Log. 22617		
	H E	Log. 72175 *A.*		
Distance of Capell. from the orbit	E F	Log. 94792	22° 48′ 7″	Dist. from the orb.
Later E I, dist. of the com. and Cap.	23° 27′ 0″	Log. 92143 *S.*		
Angle F I E		Log. 2649	76° 52′ 10″ F I E	
426				

[424] set unruled, in the page's own columns, the observation figures 1 and 2 at the head of their lines, as printed. The time marks are printed only over the first time, there as a degree circle over the hour and minute and second marks, and the angle marks only over the first distance; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 6 30 or 35 0. The abbreviations *m.* and *vesp.* after the times are never expanded in the table and are kept as printed. The page prints the difference of the distances as 35 0, where 23 27 0 less 22 52 30 gives 34 30; all three are kept as printed.

[425] set as above. The marks are printed after 17 0 12 and 29 4 17; the rest are supplied in the house form; no figure is supplied. The signs ♊ and ♉ stand after the longitudes, as printed. The tags *A.* and *S.* and the point-letters are the page's own; "Log" stands without a point before 72175, as printed.

[426] set unruled, in the page's own columns, continuing the calculation under Investigation XVII; the first line restates the last line of the previous page. The marks are printed after 53 7 5 and after 180, and as column heads over 22 48 7; the rest are supplied in the house form; no figure is supplied. The label "Dist. from the orb." is set over two lines at the end of the fifth and sixth lines, as printed. The tags *A.* and *S.* and the point-letters are the page's own.

[Margin: Diſtantia Capellæ ab orbitâ.] *The distance of Capella from the orbit.*

Diagram. The left of two engraved circles set side by side in one plate across the measure. Inside the circle are drawn the horizon M L, the ecliptic, the equator and the orbit of the comet as arcs, with straight and dotted lines joining the star E (Capella, marked by a star) and the comet C (a small circle) to points on the circle. Caption beneath: "Die 29 Hor. 4 10′ 50″ m." (on the 29th at $4^h\ 10^m\ 50^s$ in the morning). Figure mark: BB.

- A (top of the circle)
- F, S (on the circle, upper right)
- Q, P (on the circle, upper left; Q a script capital)
- R, V (on the circle, right)
- M, L (ends of the horizon, left and right)
- X (on the circle, lower left), N (on the circle, lower right)
- E (the star, beside the label "Capel.")
- C (the comet), with D, I, G inside the circle near it
- T, K, O (on the horizon), Y (below the horizon)
- "Capel." (Capella), "Ecliptica." (the ecliptic), "Æquator." (the equator), "Horizon." (the horizon), "Orbita Com." (the orbit of the comet), "Occidens." (the west)
- BB (figure mark)

Diagram. The right of the two circles. The horizon M L, the ecliptic, the equator and the orbit of the comet are drawn as arcs; Capella at B (marked by a star) and the comet at C (a small circle) are joined by straight and dotted lines to each other and to F, A and V at the top of the circle. Caption beneath: "Die 30 Hor 6 41′ 50″ v." (on the 30th at $6^h\ 41^m\ 50^s$ in the evening). Engraver's signature at the lower right: "Autor ſculps." (the author engraved it). Figure mark: Cc.

- F, A, V (top of the circle)
- S (on the circle, upper left)
- Q, P (on the circle, upper right; Q a script capital)
- B (Capella, beside the label "Capella."), C (the comet), with E, H, W, D between them
- Y, T (right, inside the circle)
- M, L (ends of the horizon)
- O (on the horizon); a letter at the end of "Æquat." on the horizon, read as R or K [?]
- N (on the circle, lower left)
- "Capella.", "Ecliptica." (the ecliptic), "Æquat." (the equator), "Horizon." (the horizon), "Orbita Cometæ" (the orbit of the comet)
- Cc (figure mark)

For the correction of the later distance E I of the comet and Capella, and the reduction to the vertical, at $4^h\ 10^m\ 50^s$.

Proper motion from the tab. L I	3° 11′ 42″	Logar. 288716		L I Antil. 155.557
Angle F I E	76° 52′ 10″	Logar. 2647 *A.*		
Perpendicular L M		Logar. 291365	3° 6′ 41″	Antil. 147.517 *S.*
Antil. E M 8079.905			I M Antil. 8.040	0° 43′ 36″
Antil. L M 147.517 *A.*			Later dist. E I	23° 27′ 0″
Antil. E L 8227.222	22° 55′ 27″ or E I corrected		E M	22° 43′ 24″
Earlier dist. E L	22° 52′ 30″			
Diff. of the corr. dist., or Parall.	2′ 57″ fictitious.			

427

[Margin: Parallaxis ficta.] *The fictitious parallax.*

This parallax, moreover, is now very easily reduced to the vertical, since both the angle E C D and the altitudes of the comet and Capella are already established from the preceding calculation, XVI.

Mesol. of the side C G of the fictitious parall.	2′ 57″	706077	
Antil. of the angle E C D	28° 2′ 44″	12493 *S.*	
Mesol. of the parall. reduced to the vertical, C I		693584	3′ 21″.

428

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*

To derive the prosthaph. of inclination, let there first be sought the altitude and azim. of the com. and of Capell. for d. 30, at 6^h 41^m 50^s in the evening.

Altitude of Capella.

Altitude of the comet.

[427]set as above. The marks are printed after 3 11 42 and 3 6 41, and as column heads over 0 43 36 and 22 55 27; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 57. The tags *A.* and *S.* and the point-letters are the page's own. The page prints the logarithm of the angle F I E as 2647 in the second line, where the seventh line of the table above prints 2649 for the same angle and 291365 is 288716 plus 2649; and it prints the antilogarithm of E L as 8227.222, where 8079.905 plus 147.517 gives 8227.422. All are kept as printed.

[428]set as above. The marks are printed after 2 57 and 3 21; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 57 or 3 21.

Right asc. of the Sun	280° 42′ 0″			
Elong. from the merid.	100° 27′ 30″ *A.*			
Right asc. of the midheaven	21° 9′ 30″	Excess over 360°	21° 9′ 30″	Right asc. of the midheaven.
Right asc. of Capella	72° 46′ 0″ *S*		41° 8′ 0″	Right asc. of the comet.
Dist. from the merid.	51° 36′ 30″	Logar. 24360	19° 58′ 30″	Logar. 107490
Declin. of Capell.	45° 35′ 30″	Antil. 35701 *A.*	40° 35′ 0″	Antil. 27515 *A.*
Perpend. B F	33° 16′ 0″	Logar. 60061	15° 1′ 0″	Logar. 135005 Perp. C V

429

Logar. of the declin. 33635			Log. of the declin. 42993		
Ant. of the perp. B F 17897 *S.*		Ant. 17897	Ant. C V 3475 *S.*		Ant. 3475
Ant. S F 15738	31° 18′ 30″		Ant. S V 39518	47° 39′ 0″	
S A	35° 37′ 0″		S A	35° 37′ 0″	
A F	4° 19′ 0″	Ant. 284 *A.*	A V	12° 2′ 0″	Ant. 2222 *A.*
Altitude of Capell. B K	56° 29′ 13″	Log. 18181	Log. C V 135005	70° 50′ 31″	Log. 5697 Alt. of the
Log. of the perp. B F 60061			Ant. of the altit. 111377 *S.*		com.
Antil. of the alt. 59388 *S.*			Log. of the azim. of the com. 23628	52° 9′ 0″	*Orient. M.*
Log. of the azim. 673	83° 22′ 0″	Azim. *O. S.*	Azim. of Capell.	83° 22′ 0″	*Orient. S.*
			The angle sought, B A C	135° 31′ 0″	Sum.
				44° 29′ 0″	Compl. to 180°.

430

Investigation of the angle A B C, A B D, and C B D of inclin., and also of the prosth. of the first equat., according to axiom 7. Add.

[429] the two column heads stand side by side over the two groups of figures, as printed. The marks are printed after 280 42 0 and as column heads over the right-hand 21 9 30, and 360 is followed by "gr."; the rest are supplied in the house form; no figure is supplied. The tags *A.*, *S.* and *S* (printed without a point) are the page's own; the right-hand group sets its labels after its figures, as printed.

[430] set unruled, in the page's own columns, continuing the altitudes and azimuths captioned on the previous page: the left half for Capella, the right half for the comet. The marks are printed after 31 18 30, 47 39 0 and 180; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before any value the page sets without one. "Alt. of the / com." is one label set over two lines at the right, as printed. The tags *A.*, *S.*, *O. S.*, *Orient. M.* and *Orient. S.* are the page's own and are kept unexpanded. The page prints A F as 4 19 0, where 35 37 0 less 31 18 30 gives 4 18 30; all three are kept as printed.

Angle B A C	44° 29′ 0″	Log. 35567			
Compl. of the altit. of the com.	19° 9′ 24″	Log. 111427 *A.*			
		Log. 146994			
Dist. of the com. and Capell.	23° 27′ 0″	Log. 92143 *S.*			
Angle A B C		54851	35° 17′ 47″ A B C.		
Angle B A C	44° 29′ 0″	Log. 35567			
Compl. of the altit. of Capell.	33° 30′ 47″	Log. 59400 *A.*		Antil. 18180	
Perpend. D E		Log. 94967	22° 45′ 34″	Antil. 8106 *S.*	
Side E B	8° 13′ 27″	Log. 194457 + *S. Cosf.*		Antil. 10074	25° 17′ 20″ A E
Perpendic. D E	22° 45′ 34″	Mes. 86777 +			33° 30′ 47″ A B
		Mes. 107680 —	71° 11′ 13″ D B A		8° 13′ 27″ E B
			35° 17′ 47″ A B C		
		Log. 53402 *A.*	35° 53′ 26″ D B C	Angle of inclinat. of the first equat.	
Parall. reduced to the vertic.	3′ 21″	Log. 693584			
Prosth. of the incl. of the first equat. C W		Log. 746986	1′ 58″ *A.*		
	Parall. reduced to the vertical was		3′ 21″		
	Parall. vertic. equated a first time		5′ 19″		

431

[Margin: Parallaxis primò coæquata.] *The parallax equated a first time.*
For the prosthaphaeresis of the second equat. C D. Add.

[431]set as above. The marks are printed after 25 17 20, 3 21 and 1 58, as column heads over 35 17 47, 71 11 13 and 76 26 34, and after the first 44 29 0, where the sort after 44 is not settled between a degree circle and a small figure 6 and the minute place carries a double stroke; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 3 21, 1 58 or 5 19. The tags *A.*, *S.* and *S. Cosf.*, the sign +, the long dash after 107680 and the point-letters are the page's own. The page prints the complement of the comet's altitude as 19 9 24, where 90° less the altitude of the comet, 70 50 31, gives 19 9 29; both are kept as printed.

Dist. C B of the com. and Capell.	23° 27′ 0″	Log. 92143 *S.*			
Perpend. D E, or B H	22° 45′ 34″	Log. 94967			
Angle B C D		Log. 2824	76° 26′ 34″ B C D		
Dist. C B of the com. and Cap.	23° 27′ 0″	Log. 92143		Mesol. 83523 + *S. Cofs.*	
Angle of inclin. D B C	35° 53′ 26″	Log. 53402 *A.*			
Perpendic. C W		Log. 145545	13° 29′ 28″ B C W	Mes. 142748 + Antil. 59225 + B C D	56° 24′ 17″ 76° 26′ 34″
Prosth. of the inclin. of the first equat. C W	1′ 58″	Mes. 746986 +			
Angle W C D of inclin. of the second eq.	20° 2′ 17″	Ant. 6244 + *S.*	Angle of incl. of the second eq. W C D		20° 2′ 17″
Prosth. of the second equat. C D		Mes. 740742 +	2′ 5″	Add. according to axiom 7.	
	Parallax reduced to the vertical		3′ 21″		
	Therefore the genuine vertical parallax, equated a second time		5′ 26″	For the altitude of the comet	
16° 17′, observed on December 29 at 4^h 10^m 50^s *m.*; which was to be computed.					

[432]

However, since no other observations remain for the 29th, let us turn to the 30th. Let us therefore investigate the parallax, first from the distances of the comet and the Heel taken at 6^h 10^m 30^s in the evening on December 30, and at 3^h 37^m 26^s in the morning on December 31. Since these were not observed with instruments, it is neces-

[Margin: Calculus parallaxeos pro die 30 Decemb.] *Calculation of the parallax for December 30.*

[432] set as above. The marks are printed after 23 27 0 (set above the figures), after 2 5, after 16 17 and over the minutes and seconds of the hour, and as column heads over 76 26 34 and 56 24 17; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 58, 2 5, 3 21 or 5 26. The tags *A.*, *S.* and *S. Cofs.*, the sign + and the point-letters are the page's own; the abbreviation *m.* after the time is kept as printed.

sary first to derive them from the longitudes and latitudes. For the earlier observation, the longitudes and latitudes were determined from distances, and there refraction would necessarily have had to be taken into account, unless the comet had stood 66° high at that time. For the later observation, however, the longitudes and latitudes came out of altitudes and azimuths corrected for refraction, so that no further correction is needed here. I was glad to point this out at this place, partly so that you may see my care, and partly so that you may not be unaware of when, and in which distances, refractions are to be applied.

Investigation of Parallax XVIII, from the Distances of the Comet and the Heel, Computed, for December 30 [Inveſtigatio parall. XVIII. Ex Diſtantiis Cometæ & Calcanei ſupputatis, ad diem 30 Decembr.]

1 Obs. Dec. 30, at	6^h 10^m 30^s in the evening.	The comet and the Heel under the same vertical circle.			
2 Obs. Dec. 31, at	3^h 37^m 26^s in the morning.	The comet and the Heel almost equidistant from the horizon.			
Difference	9^h 26^m 56^s				
Long. of the com., 1 obs.	21° 27′ 48″ ♉	Latitud. of the com.	23° 23′ 17″ north	Latit. of the Heel	12° 8′ north
Long. of the Heel	26° 17′ 12″ ♉	Its compl.	66° 36′ 43″ A L	Compl. A E	77° 52′
Angle E A K	4° 49′ 24″				
Log. of the compl. of the latit. of the Heel	2259 A E	Antil. 155975			
Log. of the angle E A K	247593 *A.*				
Log. of the perpendicular E K	249852	4° 42′ 56″	Antil. 339 *S.*	Antil. 339 E K	
		A K	Antil. 155636	77° 49′ 20″	
			A L	66° 36′ 43″	
			K L	11° 12′ 37″	Ant. 1927 *A.*
			Dist. of the com. and the Heel	12° 9′ 9″	Ant. 2266 E L.

433

[Margin: Diſtantia Cometæ & Calc.] *The distance of the comet and the Heel.* **For the later distance.**

433set unruled, in the page's own columns. The marks are printed after the minutes and seconds of the first time, after 21 27 48, 23 23 17, 12 8 and 4 42 56, and as column heads over 77 49 20; the rest are supplied in the house form; no figure is supplied. The sign ♉ (Taurus), the tags *A.* and *S.* and the point-letters are the page's own.

Long. of the com., 2 obs.	21° 14′ 22″ ♉	Latitud. of the comet	23° 58′ 19″ north	
Long. of the Heel	26° 17′ 12″ ♉	Its complem.	66° 1′ 41″ A I	
Angle E A D	5° 2′ 50″			
Log. of the compl. of the latit. of the Heel	2259	A E Antil. 155975		
Log. of the angle E A D	243068 *A.*			
Log. of the perpendic. E D	245327	4° 56′ 3″	Antil. 371 *S.*	
		A D	Antil. 155604	77° 49′ 13″
Antil. I D 2133			A I	66° 1′ 41″
Antil. E D 371 *S.*			I D	11° 47′ 32″
Antil. I E 2504	12° 46′ 9″	Later dist. of the com. and the Heel.		
	12° 9′ 9″	Earlier dist. of the com. and the Heel.		
Difference of the distances, or	37′ 0″	the mean, or fictitious, apparent motion.		

434

[Margin: Motus viſus medius.] *The mean apparent motion.*

Since, then, the Heel is a little distant from the orbit, its distance from the orbit must first be found; then the mean apparent motion, or the difference of the distances, must be corrected, or, what is the same thing, the later distance E I must be limited, as we usually do for fixed stars set not very far from the orbit.

Longitud. of the Heel	56° 17′ 12″			
Point of intersect. of the orb.	58° 36′ 0″ for December 31			
Difference G H	2° 18′ 48″	Antil. 82		
Latit. of the Heel E G	12° 8′ 0″	Antil. 2259 *A.*	Latitud.	Logar. 155975
H E		Antil. 2341	12′ 21′ 0″	Logar. 154233 *S.*
		Angle G H E	79° 20′ 12″	Logar. 1742
		Angle of the orbit and the eclipt. A H F	74° 7′ 0″	
		There remains the angle E H F	5° 13′ 12″	Logar. 239681
		H E		Logar. 154233 *A.*

[434] set as above. The marks are printed after 21 14 22, 23 58 19 and 4 56 3, and as column heads over 77 49 13 and 12 46 9; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 37 0. The sign ♉, the tags *A.* and *S.* and the point-letters are the page's own.

		Distance of the Heel from the orbit, E F	1° 6′ 15″	Logar. 393914

435

[Margin: Diſtantia Calc. ab orbitâ.] *The distance of the Heel from the orbit.*

Earlier dist.	12° 9′ 9″	Antil. 2266.419 E L		
Dist. from the orb.	1° 6′ 15″	Antil. 18.570 *S.*		
F L		Antil. 2247.849	12° 6′ 11″	Corr. dist. F L.
Later dist.	12° 46′ 9″	Antil. 2504.252		
Dist. from the orb.	1° 6′ 15″	Antil. 18.570 *S.*		
I F		Antil. 2485.882	12° 43′ 20″	Corr. dist. I E
		Corrected apparent motion	37′ 9″	
		Proper motion from the tab. corresponding to $9^h\ 26^m\ 56^s$	37′ 48″	
		Fictitious parallax, or parallax of the orbit	39″	

436

[Margin: Parallaxis Orbitæ.] *The parallax of the orbit.*

Although this fictitious parallax, or parallax of the orbit (namely the difference between the apparent and the true motion), is very slight, and is almost the vertical parallax itself, at an altitude of 67° on the 30th at $6^h\ 10^m\ 30^s$, so that it can differ only very little from the true and genuine parallax, nevertheless, as is our custom, since the matter is difficult, let us first reduce it to the vertical, and then investigate its prosthaphaeresis of both the first and the second equation, so that it may come out all the more accurately how great the parallax is altogether at the given altitude: whether, that is, it is still gradually decreasing or not.

Diagram. The left of three engraved figures set side by side across the measure. Three arcs are drawn down from A to an arc at the foot marked G, H, C, I; the orbit of the comet runs up to the right through L and I. Dotted

[435] set as above. The marks are printed after 56 17 12, after 12 21 0 and after 1 6 15; the rest are supplied in the house form; no figure is supplied. After 12 in the fifth line the page prints a minute mark where a degree mark would stand, and it is given as printed. The tags *A.* and *S.* and the point-letters are the page's own.

[436] set unruled, in the page's own columns, continuing the calculation above. The marks are printed after 12 9 9, after 12 6 11 and after the minutes and seconds of the hour; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 37 9 or 37 48, nor any minute figure before 39. The tag *S.* and the point-letters are the page's own. The page prints the antilogarithm of I F as 2485.882, where 2504.252 less 18.570 gives 2485.682; all are kept as printed.

lines join D and K on the left arc to I and L. The star E (marked by a star), labelled "Calc." above and "Algol." below, is joined by straight lines to I and L, by dotted lines to D, K and F, and by a dotted arc down towards H. Figure mark: DD.

- A (apex)
- "Orbit. Comet." (the orbit of the comet), along the line through I
- D, K (on the left arc, upper)
- I, L (on the orbit; small circles)
- D, K, F (right of E, at the ends of the dotted lines)
- E (the star), with "Calc." (the Heel) above and "Algol." (Algol) below
- G, H, C, I (on the arc at the foot)
- DD (figure mark)

Diagram. The middle figure, a circle. The horizon M L, the ecliptic, the equator and the orbit of the comet are drawn as arcs. The comet C (a small circle) stands near the top, joined by lines to R and A at the top of the circle and by a dotted line to a third letter beside them; the arc B C D crosses the circle; S stands above the circle, joined by dotted lines to B and A. Caption beneath: "Die 30. Hor. 6 10′ 30″ v." (on the 30th at 6^{h} 10^{m} 30^{s} in the evening). Figure mark: EE.

- S (above the circle)
- R, A (top of the circle), and a third letter beside them, read as E or F [?]
- B (on the circle, upper left), C (the comet), D (on the circle, right)
- Q, P (on the circle, upper right; Q a script capital)
- I, G (joined by a short dotted line), H (on the orbit)
- M, L (ends of the horizon), K (on the horizon)
- N (on the circle, lower left)
- "Ecliptica." (the ecliptic), "Horizon." (the horizon), "Æquator." (the equator), "Oriens." (the east), "Orbita Comet." (the orbit of the comet)
- EE (figure mark)

Diagram. The right figure, a circle. The horizon M I, the ecliptic, the equator and the orbit of the comet are drawn; the star B (marked by a star) with E above it and the comet C (a small circle) with H, W and D below it are joined by straight and dotted lines to each other, and by dotted lines to F and V. on the circle at the right. Caption beneath: "Die 31. Hor. 3 37′ 26″ m." (on the 31st at 3^{h} 37^{m} 26^{s} in the morning). Engraver's signature at the lower right: "Autor ſculp." (the author engraved it). Figure mark: FF.

- A (top of the circle), S (on the circle, upper right)
- Q, P (on the circle, upper left; Q a script capital)
- F, V. (on the circle, right)
- C (the comet), with H, W, D near it
- E, B (B the star)
- M, I (ends of the horizon), K, O (on the horizon)
- N (on the circle, lower right)

- "Calcan. vel Alg." (the Heel, or Algol), "Ecliptica." (the ecliptic), "Æquator." (the equator), "Horizon." (the horizon), "Orbita Comet." (the orbit of the comet), "Occidens." (the west)
- FF (figure mark)

For the altitude and azim. of the comet at $6^h\ 10^m\ 30^s$.

Right asc. of the Sun	280° 42′ 23″				
Elong. from the merid.	92° 37′ 30″ *A.*				
Right asc. of the midheaven	13° 19′ 53″	excess over 360°.			
Right asc. of the comet	41° 10′ 12″				
Dist. from the merid.	27° 50′ 19″	Logar. 76147			
Declin. of the comet	40° 33′ 40″	Antil. 27481 *A.*	Declinat.	Logar. 43037	
	C F	Logar. 103628	20° 46′ 46″	Antil. 6725 *S.*	
			B F	45° 56′ 0″	Antil. 36312
Logar. of the perp. 103628				35° 37′ 0″	
Antil. of the altit. 93574 *S.*			F A	10° 19′ 0″	Antil. 1630
Logar. of the azim. 10054	64° 44′ 10″	Azim. of the com.	C F	Antil. 6725	
		Altit. of the comet C K	Logar. 8355	66° 54′ 10″	

437

[Margin: Azimuth Cometæ.] *The azimuth of the comet.*
For the reduction of the parall. of the orbit to the vertical.

Angle of the orb. and the equat. D H C	63° 10′ 0″	Antil. 79541	
Declin. D C north	40° 33′ 40″	Antil. 27481 *S.*	
Angle of the orbit and the declin.		Logar. 52060	36° 27′ 10″ H C D
Compl. of the elev. of the pole A B	35° 37′ 0″	Logar. 54067	
Azim. L K or S A B	64° 44′ 10″	Logar. 10054 *A.*	
	Sum	Logar. 64121	
Compl. of the declin. C B	49° 26′ 20″	Logar. 27481 *S.*	
Angle of the vertical and the declin.		Logar. 36640	43° 53′ 10″ B C S or I C D
		Angle of the orbit and the vertical sought	7° 26′ 0″ I C G
Mesolog. of the side C G, or the parall. of the orbit, 39″		857335	

[437] set unruled, in the page's own columns: the left-hand column of the lower lines works the azimuth, the right-hand groups the altitude. The marks are printed after 280 42 23, 20 46 46, 64 44 10 and 66 54 10, and 360 is followed by "gr."; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the point-letters are the page's own.

Antilog. of the angle I C G just found	844 *S.*	
Mesol. of the parall. reduced to the vertical	856491	39½″.

438

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*

To find the prosthaph. of inclination, let there be computed, 1, the altitudes

of the Heel for d. 31 at 3^h 37^m 26^s. — of the comet for d. 31 at 3^h 37^m 26^s.

Right asc. of the Sun	281° 8′ 20″					
Elong. from the merid.	234° 21′ 30″ *A.*					
Right asc. of the midheaven	155° 29′ 50″		360° rejected.		155° 29′ 50″	Right asc. of the midheaven
Right asc. of the Heel	50° 39′ 37″				40° 40′ 53″	Right asc. of the comet
Its compl.	104° 50′ 13″		to 180°.		114° 48′ 57″	Its compl. to 180° is the dist. from the merid.
Dist. from the merid.	75° 9′ 47″		Logar. 3391		65° 11′ 3″	Logar. 9683
Declinat. of the Heel	31° 7′ 38″		Antil. 15546 *A.*		41° 3′ 7″	Antil. 28221 *A.*
Perpend. B V	55° 50′ 30″		Logar. 18937	C F	43° 11′ 54″	Logar. 37904
Logar. of the declin.	65983			Log. of the decl. 42046		
Antil. B V	57717 *S.*		Ant. 57717	Ant. C F 31612 *S.*		Ant. 31612
Antil. S V	8266	22° 58′ 35″		Ant. S F 10434	25° 43′ 20″	
	S A	35° 37′ 0″		S A	35° 37′ 0″	
	A V	58° 35′ 35″	Ant. 65179 *A.*	A F	61° 20′ 20″	Ant. 73475 *A.*
Altitude of the Heel		17° 0′ 48″	Log. 122896	Altitude of the comet	20° 27′ 54″	Log. 105087
Logar. of the perp. B V 18937				Log. of the perp. C F	37904	
Antil. of the altit.	4475 *S.*			Antil. of the altit.	6519 *S.*	
Log. of the azim.	14462	59° 55′ 20″	azim. of the Heel *Occ. S.*	Log. of the azim.	31385	46° 56′ 18″
		46° 56′ 18″	azim. of the com. *Occ. S.*			

438 set unruled, in the page's own columns. The marks are printed after 63 10 0, 36 27 10 and the seconds 39, and as a column head over 39½; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the point-letters are the page's own.

Angle B A C	12° 59′ 2″

439

[Margin: Altitudines Calcanei & Cometæ.] *The altitudes of the Heel and the comet.*

2. The angles A B C, A B D and C B D of inclinat.

Angle B A C	12° 59′ 2″	Logar. 149308			
Compl. of the altit. of the com.	69° 32′ 6″	Logar. 6520 *A.*			
	Sum	Logar. 155828			
Dist. of the com. and the Heel	12° 46′ 9″	Logar. 150968 *S.*			
		Logar. 4860	72° 16′ A B C		
Angle B A C	12° 59′ 2″	Logar. 149308			
Compl. of the alt. of the Heel	72° 59′ 12″	Logar. 4477 *A.*		Ant. 122896	
Perpend. D E		Logar. 153785	12° 25′ D E	Antil. 2367 *S.*	
Side E B	25′ 0″	Logar. 492370 + *S. Cof.*		Ant. 120529	A E 72° 34′
Perpend. D E	12° 25′ 0″	Mesol. 151336 +			A B 72° 59′
Angle D B A		Mesol. 341034 —	88° 7′ A B D 72° 16′ A B C		E B 25′
Angle of inclinat. D B C		Logar. 129784	15° 51′ D B C		
Parall. reduced to the vert. was 39½″		Logar. 856491 *A.*			
Prosthaph. of the inclinat. C W		Logar. 986275	0′ 11″ Subt. prosthaph.		
		The parallax reduced to the vertical was	0′ 39½″		
		The parallax equated a first time becomes	0′ 28½″		

440

439 set unruled, in the page's own columns: the left four columns work the Heel, the right three the comet, as the two halves of the caption head them; the dash between the halves of the caption is the translation's. The marks are printed after 281 8 20, after 180 on the right, after the right-hand 46 56 18, and as column heads over the right-hand 155 29 50, over 22 58 35, 25 43 20 and 59 55 20; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.*, the direction tag *Occ. S.* and the point-letters are the page's own.

440 set as above. The marks are printed after 12 59 2 in the first line and after 0 11, and as column heads over 72 16 in the fifth line, over A E's 72 34 and over the 39½ of the parallax reduced to the vertical; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 25 0, E B's 25, 0 11, 0 39½ or 0 28½. The tags *A.*, *S.* and *S. Cof.*, the signs + and —, "Subt." and the point-letters are the page's own.

[Margin: Parallaxis primò coæquatâ.] *The parallax equated a first time.*
For the prosth. of the second equat. C D. Subtr.

Dist. C B of the com. and the Heel	12° 46′ 9″	Log. 150968 *S.*			
Perp. E D or B H	12° 25′ 0″	Log. 153785			
Angle B C D		Log. 2817	76° 28′	B C D	
Dist. C B of the com. and the Heel	12° 46′ 9″	Log. 150968		Mesol. 148464 + *S. Cof.*	
Angle of inclin. D B C	15° 51′ 0″	Log. 129784 *A.*			
Perpend. C W		Log. 280752	3′ 28″	Mesol. 280381 +	
Prosth. of the inclin. C W	0° 0′ 11″	Mesol. 984852		Ant. 131917 +	74° 30′ B C W
Angle of inclin. of the 2nd equat.	1° 58′ 0″	Ant. 59 *S.*			76° 28′ B C D
Prosth. of the inclin. of the 2nd equat. C D		Mesol. 984793	0′ 11″	Angle of inclinat.	1° 58′ W C D
		Parall. reduced to the vertical	0′ 39½″		
		Therefore the genuine vertical parallax, equated a second time observed on December 30 at $6^h\ 10^m\ 30^s$.	0′ 28½″	For the altitude of the comet 66° 54′ 10″,	

441

But since from this calculation the parallax might perhaps seem to someone too slight, let us therefore go again in search of the same for this same day, and that from other, different observations, namely from computed distances of the comet and the Heel. The earlier, vertical observation was made at $6^h\ 41^m\ 50^s$ on December 30; the later, parallel one is the same one that was used in the preceding investigation. Let us therefore use the preceding figures in turn, and follow the same course of calculation.

[Margin: Eadem parallaxis rursùs inveſtigatur.] *The same parallax is investigated again.*

Investigation of Parallax XIX, from the Distances of the Comet and the Heel, Computed, for December 30 [Inveſtigatio Parallaxeos XIX. Ex diſtantiis Cometæ & Calcanei ſupputatis, ad diem 30 Decemb.]

For the earlier distance.

[441] set unruled, in the page's own columns. The marks are printed after 12 46 9 in the first line, after 76 28 and 66 54 10, and as column heads over 74 30 and over 0 11; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 3 28, 0 11, 0 39½ or 0 28½. The tags *A.*, *S.* and *S. Cof.*, the signs + and the point-letters are the page's own.

1 Obs. d. 30 at	$6^h\ 41^m\ 50^s$ *vesp.*				Vertical.
2 Obs. d. 31 at	$3^h\ 37^m\ 26^s$ *m.*	Altitud. of the com.	20° 27′ 54″	Azim. 46° 56′ 18″ *Occ. S.*	Parallel.
Long. of the com., 1 obs.	21° 27′ 0″ ♉	Latit. of the com.	23° 26′ L C.	Latitud. of the Heel	12° 8′ E G.
Long. of the Heel	26° 17′ 12″ ♉	Complem.	66° 34′ A L.	Complem.	77° 52′ E A.
Angle E A K	4° 50′ 12″				
Log. of the compl. of the latit. of the Heel E A	2259		Antil. 155975		
Log. of the angle E A K	247318 *A.*				
Log. of the perp. E K	249577	4° 43′ 42″	Antil. 341 *S.*		E K Ant. 341
		A K	Antil. 155634	77° 49′ 29″	
			A L	66° 34′ 0″	
			L K	11° 15′ 29″	Ant. 1943 *A.*
		Earlier dist. of the comet and the Heel E L		12° 12′ 0″	Ant. 2284

442

[Margin: Diſtantia Cometæ & Calc.] *The distance of the comet and the Heel.*

There is no reason for us to seek the later distance, at $3^h\ 37^m\ 26^s$, since it has already been found in the preceding calculation, 12° 46′ 9″, and also corrected and limited; and therefore it is necessary to limit only the earlier distance.

Earlier dist.	12° 12′ 0″	Antil. 2284.304		
Dist. of the Heel from the orb.	1° 6′ 15″	Antil. 18.570 *S.*		
Corrected earlier dist. F L		Antil. 2265.734	12° 9′ 3″ F L	
		The later corrected dist. was	12° 43′ 20″ F I	
		Corrected apparent motion	34′ 17″	
		True proper apparent motion from the tab. for $8^h\ 55^m\ 36^s$	35′ 43″	Hence, since the true proper motion
		is greater than the apparent, therefore the parallax of the orbit is	1′ 26″	

[442] set as above. The marks are printed after the minutes and seconds of the first time, after 20 27 54, 46 56 18, 21 27 0, 23 26, 12 8, 4 43 42 and 77 49 29; the rest are supplied in the house form; no figure is supplied. The sign ♉ (Taurus), the tags *A.* and *S.*, the abbreviations *vesp.* and *m.*, the direction tag *Occ. S.* and the point-letters are the page's own.

443

[Margin: Parallaxis Orbitæ.] *The parallax of the orbit.*

Let us now reduce this to the vertical, after we have computed the azimuth and the altitude of the comet.

The altitude of the comet at 6^h 41^m 50^s in the evening.

Right asc. of the Sun	280° 43′ 0″					
Elong. from the merid.	100° 27′ 30″ *A.*					
Right asc. of the midheaven	21° 10′ 30″	360 degrees cast off.				
Right asc. of the comet	41° 9′ 30″					
Dist. from the merid.	19° 59′ 0″	Log. 107368				
Declin. of the com.	40° 36′ 0″	Ant. 27540 *A.*		Log. 42959		
	C F	Log. 134908	15° 2′ 21″	Ant. 3485 *S.*		Ant. 3485
	Antil. of the altit.	111394 *S.*		Ant. 39474	47° 38′ 0″	
Azim. of the com. *Orient. M.*		Log. 23514	52° 13′ 40″		35° 37′ 0″	
					12° 1′ 0″	Ant. 2216 *A.*
				Altit. of the comet	70° 50′ 12″	Ant. 5701

444

[Margin: Altitudo Cometæ.] *The altitude of the comet.*

For the reduction of the parall. of the orbit to the vertical.

Angle of the orbit and the equat. D H C	63° 10′ 0″	Antil. 79541	
Declinat. D C north	40° 38′ 0″	Antil. 27589 *S.*	
Angle of the orbit and the declin.		Logar. 51952	36° 30′ H C D
Compl. of the elev. of the pole A B	35° 37′ 0″	Logar. 54067	
Azim. L K or S A B	52° 13′ 40″	Logar. 23514 *A.*	
		Logar. 77581	

[443]set as above. The marks are printed after 12 12 0, after 12 9 3 and after the minutes and seconds of the hour; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 34 17, 35 43 or 1 26. The sentence that opens at the right of the sixth line continues at the left of the seventh. The tag *S.* and the point-letters are the page's own.

[444]set unruled, in the page's own columns. The marks are printed after 280 43 0, 15 2 21 and 47 38 0; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.*, the direction tag *Orient. M.* and the point-letters are the page's own.

Compl. of the declin. C B	49° 22′ 0″	Logar. 27589 *S.*	
Angle of the vertical and the declinat.		Logar. 49992	37° 20′ B C S or I C D
		Angle of the orbit and the vertical sought	0° 50′ I C G
Mesol. of the side C G, the parall. of the orbit	1′ 26″	778257	
Antil. of the angle of the orb. and the vertical I C G	50′ 0″	11 *S.*	
Mesol. of the parall. reduced to the vertic.		778246	1′ 26″ Mean vertic. parall.

445

[Margin: Parallaxis media.] *The mean parallax.*

But since the angle of the orbit and the vertical is very acute — indeed, the orbit almost coincides with the vertical — the parallax is therefore not changed at all, but remains exactly the same. Nevertheless, because of the later, parallel distance, it must still be equated. This, however, can be done more quickly here, since from the preceding calculation, for the same time, namely 3^{h} 37^{m} 26^{s}, we already have at hand the angle of both the first and the second equation.

For the prosthaph. of the first equation. Subt.

Parall. reduced to the vertical C I or C W	1′ 26″	Log. 778257	
Angle D B C of inclin.	15° 51′ 0″	Log. 129784 *A.*	
Prosth. of the inclin. of the first equat. C W		Log. 908041	0′ 24″ *S.*
		The parall. reduced to the vertical was	1′ 26″
		Therefore the vertical parallax equated a first time	1′ 2″

For the prosthaph. of the second equation. Subt.

Prosthaph. of the inclin. of the first equat.	24″	Mesol. 905886	
Angle W C D	1° 58′ 0″	Antil. 59 *S.*	
Prosth. of the second equat. C D		Mesol. 905827	0′ 24″ Subt.
		The parall. reduced to the vertical was	1′ 26″

445 set as above. The marks are printed after 63 10 0 and after both 1 26, and as column heads over 36 30; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 50 0 or either 1 26. The declination is printed 40 38 0 here and 40 36 0 in the calculation of the altitude above; both stand as printed. The tags *A.* and *S.* and the point-letters are the page's own.

	Therefore the genuine vertical parall., equated a second time	1′ 2″, which is exactly the same
as the parallax equated a first time, so that it does not differ even in the seconds.		For the altitude, that is, of the comet
70° 50′ 12″, observed on December 30 at 6^h 41^m 50^s *vesp.*		

446

[Margin: Parallaxis verticalis ſecundò coæquata.] *The vertical parallax equated a second time.*

Although hardly any other parallax is to be expected for December 30 than the one just found, nevertheless, for the sake of greater certainty, let us examine it further from an observation that is in part different and new and in part already used; and that by means of distances, from the longitudes and latitudes which from the distances observed came out — distances, namely, of the comet and Algol, which are to be computed — since the said fixed star lies very close to the orbit, so that we can leave out the reduction to the orbit entirely and carry out the calculation all the more easily. The earlier observation was made on the 30th at 6^h 10^m 30^s in the evening, in the east, with the comet and Algol standing almost under the same vertical; the later one was taken on the 31st at 4^h 7^m 18^s, in the west, when both phenomena lay in a line roughly parallel to the horizon, and the comet stood only 16 or 17 degrees from the horizon. Just as something unusual, not met with until now, occurs in this later observation, so too it must itself be limited by a particular new method, since the matter is very subtle.

[Margin: Singulari hîc opus eſt limitatione.] *A special limitation is needed here.*

It should be understood, then, that so far no longitudes and latitudes have been used for finding distances in which refraction was neglected, as is clear in the two preceding examples. But in the later observation, of the 31st at 4^h 7^m 18^s, which is now to be used, refraction could not conveniently be applied at the same time, since there the longitudes and latitudes had been derived from distances; let us therefore apply it now. Here, however, it must be noted that both the comet and the fixed star were at that time very low with respect to the horizon, so that their distance from each other was as a result somewhat corrupted by parallax. But if each had stood at an equal distance from the horizon, the refraction of both would certainly have been exactly the same,

[446]set as above. The marks are printed after 1 26 and 0 24 in the first calculation, after 15, after 24, after 1 58 and after 0 24 in the second, and after 70 50 12 and 41 50; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 26, 1 2 or 24. The sentence that opens at the right of the fifth line of the second calculation runs on through the two lines below it. The tags *A.* and *S.*, "Subt." and the point-letters are the page's own.

and nothing at all would either have been added to our result or taken from it. For while the comet and Algol are raised equally together, the distance remains the same and uncorrupted. Now, however, since the comet stands somewhat higher, and moreover a far greater refraction belongs to it, as our little table of refraction attests, the distance is noticeably vitiated. It must therefore be restored right at the outset.

[Margin: Animadvertenda.] *Points to be noted.*

On this occasion I also want to remind the reader that in the two preceding investigations, namely 18 and 19, the refraction for the comet was properly observed, since the longitudes and latitudes were derived from the altitudes and azimuths; for the Heel, by contrast, although it was raised only 16° 35′ 30″, that refraction was not applied, so that the parallax may perhaps have been changed as a result by some ten seconds or so [?]. For this reason we will now work out the calculation all the more accurately, so that we may see whether some difference also arises in the parallax on that account.

It is necessary, however, that the calculation be set up again by a new method: first, for the earlier observation, finding both the altitudes and the azimuths of each phenomenon; then the distances of the comet and Algol at each observation — not, indeed, from the complement of the latitude as a side and the difference of longitude as an angle, but from the complement of the altitude and the difference of the azimuths. Above all, however, for the later observation the difference of refraction of the comet and Algol must be at hand, so that you are not unable to subtract it from the altitude of the comet (since the comet is higher than the fixed star), or, what is the same, in this case to add it to the complement of the altitude of the comet; in this way the true, limited later distance may afterwards be drawn out with respect to refraction. This will appear more clearly from the calculation itself, following the course of the earlier diagrams (except that in Figure DD the circles of latitude are circles of altitude, and the ecliptic B C G is the horizon).

[Margin: Calculus iterum novâ methodo inſtituitur, pro die 30 Decembr.] *The calculation is set up again by a new method, for December 30.*

Let us therefore always proceed by this route, as the matter demands, so that not even the smallest thing is neglected, even in the seconds — especially since the parallaxes decrease from day to day and are greatly diminished, just as if they meant to vanish completely all at once.

Investigation of Parallax XX, from the Distances of the Comet and Algol, Computed, for December 30 [Inveſtigatio parall. XX. Ex Diſtantiis Cometæ & Algol ſupputatis, ad diem 30 Decembr.]

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1 Obs. d. 30 at	$6^h\ 10^m\ 30^s$ *vesp.*	Altitud. of the com.	66° 54′ 10″	Azim. of the com.	64° 44′ 10″ *Orient. M.*

2 Obs. d. 31 $4^h\ 7^m\ 18^s$ *man.*
at

For the altitude of Algol at $6^h\ 10^m\ 30^s$.

Right asc. of the Sun	280° 42′ 23″					
Elong. from the merid.	92° 37′ 30″ *A.*					
Right asc. of the midheaven	13° 19′ 53″	360 degrees cast off.				
Right asc. of Algol	41° 23′ 0″					
Dist. from the merid.	28° 3′ 7″	Log. 75445				
Declin. of Algol	39° 35′ 0″	Ant. 26046 *A.*		Log. 45067		
		Log. 101491	21° 15′	Ant. 7041 *S.*		Ant. 7041
	Ant. of the altit.	90265 *S.*		Ant. 38026	46° 52′ 8″	
Azim. of Algol G	63° 21′ 25″	Log. 11226			35° 37′ 0″	
Azim. of the com. C	64° 44′ 10″				11° 15′ 8″	Ant. 1941 *A.*
Angle E A L	1° 22′ 45″			Altit. of Algol	66° 4′ 40″	Log. 8982

447

For the earlier distance of the comet and Algol.

Compl. of the altit. of the com. A L	23° 5′ 50″	Log. 93574		Antil. 8355		
Angle E A L	1° 22′ 45″	Log. 372686 *A.*				
Perpend. L K		Log. 466260	32′ 27″	Antil. 4		
		A K		Antil. 8351	23° 5′ 30″	
		Compl. of the altit. of Algol			23° 55′ 20″	E A
		10.648		Antil.	50′ 10″	K E
		4.451		Antil. L K		
	Antil. E L	15.099			0° 59′ 44″	Dist. of the com. and Alg.

447 set unruled, in the page's own columns. The marks are printed after 21 15 (° ′ only); the column heads ° ′ ″ stand over 46 52 8; the rest are supplied in the house form; no figure is supplied, and no seconds figure stands after 21 15. The tags *A.* and *S.* and the point-letters are the page's own.

448

[Margin: Diſtantia Cometæ & Algol.] *Distance of the comet and Algol.*
For the altitude and azim. at 4^h 7^m 18^s, December 31.
Algol. Of the comet.

Right asc. of the Sun	281° 9′ 15″					
Elong. from the merid.	241° 49′ 30″ *A.*					
Right asc. of the midheaven	162° 59′ 15″	360 degrees cast off.			162° 59′ 15″	Right asc. of the midheaven
Right asc. of Algol	41° 23′ 0″				40° 54′ 0″	Right asc. of the comet
	121° 36′ 15″	Compl. to 180 degrees			122° 5′ 15″	Log. 16578
Dist. from the merid.	58° 23′ 45″	Logar. 16054			57° 54′ 45″	Ant. 28401 *A.*
Declin. of Algol	39° 35′ 0″	Antil. 26046 *A.*		Log. 44979	39° 37′ 30″	
	Per-pend.	Logar. 42100	41° 1′ 29″			
Log. of the declin.	45067			Log. of the decl. 41752		
Antil. of the perp.	28179 *S.*	Antil. 28179		Ant. of the perp. 26106 *S.*		Ant. 26106
Antil.	16888	32° 22′ 13″		Antilogar. 15646	31° 13′ 20″	
		35° 37′ 0″			35° 37′ 0″	
		67° 59′ 13″	Antil. 98132 *A.*		66° 50′ 20″	Ant. 93313
Altitude of Algol		16° 25′ 32″	Log. 126311	Altit. of the comet	17° 38′ 5″	Log. 119419
Log. of the perp.	42100			Log. of the perp. 44979		
Ant. of the altit.	4167 *S.*			Ant. of the altit. 4813 *S.*		
Log. of the azim.	37933	43° 10′ 58″	Azim. of Algol	Log. of the azim. 40166	42° 0′ 24″	Azim. of the com. B
					43° 10′ 58″	Azim. of Algol G
				Difference	1° 10′ 30″	Angle E A I.

[448] set as above. The marks are printed after 23 5 50, 32 27, 23 5 30 and 0 59 44; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 32 27 or 50 10. The page prints 50 10 for K E, where 23° 55′ 20″ less 23° 5′ 30″ gives 49′ 50″; the printed figures stand.

449

[Margin: Azimuth Cometæ & Algol.] *Azimuth of the comet and Algol.*
For the later distance of the com. and Algol, limited by refract.

Altitude of the comet	17° 38′ 5″	Refraction 4′ 45″			
Altitude of Algol	16° 25′ 32″	Refraction 2′ 12″ *S.*			
Diff. of refract. to be added	2′ 33″	Diff. of refr. 2′ 33″			
Compl. of the altit. of the com. A I	72° 21′ 55″				
Compl. of the altit. of the com. A I corr.	72° 24′ 28″	Log. 4790		Ant. 119652	
Angle E A I	1° 10′ 30″	Log. 388706 *A.*			
Perpend. I D		Log. 393496	1° 7′ 12″	Ant. 19 *S.*	
				Ant. 119633	72° 24′ 15″ A D
				Compl. of the altit. of Alg.	73° 34′ 28″ A E
		20.859	Antil.		1° 10′ 13″ E D
		19.966	Antil. I D		
		40.825	1° 37′ 11″	Later dist. of the com. and Alg.	
			59′ 44″	Earlier dist. of the com. and Alg.	
Difference of the distances, or apparent motion			37′ 27″		
Proper motion from the tab. for $9^h\ 56^m\ 18^s$			39′ 18″		
Fictitious parallax, and at the same time that of the orbit			1′ 51″		

450

Since Algol lies almost under the orbit, this parallax needs no reduction to the orbit, but only to the vertical, following the figure E E, and it is completed

449 set as above, Algol's calculation at the left and the comet's from the middle, as on the page. The marks are printed after 281 9 15, 39 37 30, 41 1 29 and 32 22 13, and as column heads over the right 162 59 15, over 31 13 20 and over the left 43 10 58; the rest are supplied in the house form; no figure is supplied. The page prints 162 59 15 for the right ascension of the midheaven, where 281° 9′ 15″ and 241° 49′ 30″, less 360°, give 162° 58′ 45″; and 1 10 30 for the difference of the azimuths, where 43° 10′ 58″ less 42° 0′ 24″ gives 1° 10′ 34″. The printed figures stand. The tags *A.* and *S.* and the point-letters are the page's own.

450 set unruled, in the page's own columns. The marks are printed after 17 38 5, 4 45, 1 7 12, 1 37 11 and the time 9 56 18, and as column heads over 72 24 15; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 12, 2 33, 59 44, 37 27, 39 18 or 1 51. The tags *A.* and *S.* and the point-letters are the page's own.

by the shortest route: since the angle of the orbit is vertical [?], it is already established from calculation 18.

Diagram. An engraved figure in a plate-mark, standing at the left of the calculation above and the prose below it. Three arcs descend from A at the top to the horizon drawn across the foot, meeting it at G, C and B; a fourth line from A runs to L. A curve lettered "Orbita Cometæ" (the orbit of the comet) runs down from the upper left through I. D and K stand on the left arc, joined by dotted lines to I and L, which are drawn as small circles. E, a star marked "Algol.", stands on the left arc below K, joined by straight lines to I and L. A further arc lettered "Circuli Altit." (circles of altitude) runs down through L and crosses the horizon near B. "G G" stands between the left and middle arcs above the horizon, and "Horizon." at the left above the horizon line. At the foot stands the engraver's signature, "Aut." with a second word read as [?]culps. (the author engraved it).

- A (top, apex of the arcs): A
- Orbita Cometæ (upper left, along the curve): the orbit of the comet
- D (left arc, upper): D
- I (on the orbit, small circle): I
- K (left arc, below D): K
- L (right, small circle): L
- Algol. (left of E): Algol
- E (star on the left arc): E
- G G (between the left and middle arcs): figure mark G G
- Circuli Altit. (along the right arc): circles of altitude
- Horizon. (lower left, above the line): horizon
- G, C, B (under the horizon line, left to right): G, C, B
- Aut. [?]culps. (foot, right of the middle): the author engraved it

All labels printed on the figure are listed; the first letter of the signature's second word is not settled.

Mesol. of the side C G, the fictitious parall. and at the same time that of the orb.	1′ 51″	752739	
Antilog. of the angle of the orb. and the vertic. I C G	7° 26′ 0″	844 *S.*	
Mesol. of C I, the parall. reduced to the vert.	0° 1′ 52″	751895	Mean vert. par.

451

It now remains to work out the prosthaphaeresis of inclination. Here too, as in the preceding investigation for the Heel of Perseus, it is subtractive. But here it can be found somewhat more briefly, since the azimuth of each

[451] set as above. The marks are printed after 1 51; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 51. The tag *S.* and the point-letters are the page's own.

phenomenon for the later observation at $4^h\ 7^m\ 18^s$ has already been computed, and consequently their difference too (which measures the angle B A C) is already known, in Diagram FF.

[Margin: Breviori viâ rés hîc expeditur.] *Here the matter is settled by a shorter route.*

For the angle C B D of inclin. and the prosth. of the first equat. C W. Subtr.

Angle B A C	1° 10′ 30″	Log. 388706				
Compl. of the alt. of the com.	72° 24′ 18″	Log. 4790 *A.*				
		Log 393496				
Dist. of the com. and Algol	1° 37′ 11″	Log. 356661 *S.*				
Angle A B C		Log. 36835		43° 46′ 30″	A B C	
Angle B A C	1° 10′ 30″	Log. 388706				
Compl. of the alt. of Algol	73° 34′ 28″	Log. 4167 *S.*			Ant. 126313	
Perpend. D E		Log. 384539		1° 13′ 30″		Antil. 23 *S.*
Side E B	0° 0′ 14″	Log. 959786	+ *S. Coss.*		Ant. 126290	73° 34′ 14″ E
Perpend. D E	1° 13′ 30″	Mes. 384515	+			73° 34′ 28″ B
Angle D B A		Mes. 575271	—	89° 49′ 0″	D B A	14″ E B
				43° 46′ 30″	B C	
Angle of inclin. D B C	46° 2′ 16″	Log. 32878 *A.*		46° 2′ 16″	D B C	
Parall. reduced to the vertic.	1′ 52″	Log. 751895				
	C W	Log. 784773		1′ 21″ *S.*	Prosth. of the inclinat. of the first equat.	
The parallax reduced to the vertical				1′ 52″		
Therefore the vertical parallax equated a first time				31″		

452

[Margin: Parallaxis verticalis primò coæquata.] *The vertical parallax equated a first time.*

For the prosth. of inclin. of the second equat. C B. Subt.

Dist. C B of the com. and Algol	1° 37′ 11″	Log. 356661 *S.*			
Perp. D E, or B H	1° 13′ 30″	Log. 384539			
Angle B C D		Log. 27878	49° 10′	B C D	
Dist. C B of the com. and Algol	1° 37′ 11″	Log. 356661		Mesol. 356759 + *S. Coss.*	
Angle of inclin. D B C	46° 2′ 16″	Log. 32878 *A.*			
Perpend. C W		Log. 389539	1° 10′	Mesol. 389394 + Antil. 32635 +	43° 49′ B C W
Prosth. of inclin. C W	1′ 21″	Mes. 784773 +			49° 10′ B C D
Angle W C D	5° 21′ 0″	Antil. 437 + *S.*		Angle of inclin.	5° 21′ W C D
Prosth. of inclin. of the second equat. C D		Mes. 784336 +	1′ 21″ *S.*		
Parall. reduced to the vertical			1′ 52″		
Therefore the true vertical parallax equated a second time			31″		

453

For December 30, at 6^h 10^m 30^s in the evening, with the comet at an altitude of 66° 54′ 10″.

From these results, then, it is clear that the parallax obtained here — although it was investigated from entirely different observations, and also by a very careful method, likewise without neglecting the refraction appropriate to each phenomenon — nevertheless differs by scarcely a very few seconds from the parallax obtained in calculations 18 and 19. So we can be entirely certain and assured of the truth of this parallax.

452 set as above. The marks are printed after 1 10 30 in the first line, and as column heads over 43 46 50, over 73 34 14, over 89 49 6 and over 1 21; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 52, 1 21, 14 or 31. The signs + and — and the label *S. Coss.* are the page's own, kept as printed. The tags *A.* and *S.* and the point-letters are the page's own.

453 set unruled, in the page's own columns. The marks are printed after 1 37 11 (both lines), 49 10, 1 10, 43 49 and 1 21 S.; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 21, 1 52 or 31. The signs + and the label *S. Coss.* are the page's own, kept as printed. The tags *A.* and *S.* and the point-letters are the page's own.

[Margin: Parallaxinadmodùm exquiſitè eſſe determinatam, ex adeò diverſis inveſtigationibus, luculenter patet.] *That the parallax has been determined very exactly is clearly evident from investigations so different.*

Nevertheless, let us go further and seek the parallax once again for the same day, December 30: namely from the vertical observation of investigation 19 and the parallel observation of investigation 20, and likewise from the distances of the comet and Algol, with the refractions also duly observed, as was done in the preceding inquiry from the complement of the comet's altitude and the difference of the azimuths. But we shall complete this calculation by a much shorter route, since for the later observation there is no need to seek either the altitudes or the azimuths of the comet and Algol, nor to limit the distance, and — what matters most — nor to investigate the angle of inclination of either the first or the second equation. So the true parallax equated a second time can be drawn out very easily with the help of those three preceding figures, D D, E E, F F.

Investigation of Parallax XXI, from the Distances of the Comet and Algol, Computed, for December 30 [Inveſtigatio Parall. XXI. Ex Diſtantiis ſupputatis Cometæ & Algol, ad diem 30 Decemb.]

1 Obs. for d. 30 at	$6^h\ 41^m\ 50^s$ *vesp.*	Altit. of the com.	70° 50′ 12″	Azim.	52° 13′ 40″ *Or. M.*	Vertic.
2 Obs. for d. 31 at	$4^h\ 7^m\ 18^s$ *man.*	Altit. of the com.	66° 50′ 20″	Azim.	42° 0′ 24″	Parall.

454

For the altitude and azim. of Algol.

Right asc. of the midheaven	21° 10′ 30″	From calc. XIX.				
Right asc. of Algol	41° 23′ 0″					
Dist. from the merid.	20° 12′ 30″	Log. 106296				
Declin. of Algol	39° 35′ 0″	Ant 26046 *A.*		Log. 45067		
		Log. 132342	15° 26′ 22″	Ant. 3675 *S.*		Ant. 3675
	Ant. of the alt.	106898 *S.*		Ant. 41392	48° 37′ 10″	
Azim. of Algol	50° 50′ 12″	Log. of the azim. 25444			35° 37′ 0″	
Azim. of the com.	52° 13′ 40″				13° 0′ 10″	Ant. 2597

[454] the marks are printed after 6 41 50 (′ ″), 70 50 12 and 52 13 40; the rest are supplied in the house form; no figure is supplied. *Or. M.* is the page's own tag, kept unexpanded; *Vertic.* and *Parall.* name the vertical and the parallel observation.

Angle E A L	1° 23′ 28″	Logar. 371823		Altit. of Algol	69° 55′ 6″	Log. 6272
Compl. of the alt. of the com.	19° 9′ 48″	Logar. 111394 *A.*		Ant. 5711		
Perpend. L K		Logar. 483217	27′ 24″	Ant. 3.177 *S.*		
				Ant. 5708	19° 10′ 30″	A K

455

[Margin: Altitudo Algol.] *Altitude of Algol.*

			Antil. 5708		19° 10′ 30″ K K
Antilog. K E	12.491				20° 4′ 54″ E A
Antilog. L K	3.177 *A.*				54′ 20″ K E
Antilog. E L	15.668	1° 0′ 51″	Earlier dist. of the com. and Algol E L.		
		1° 37′ 11″	Later dist., limited, E I, by refract., found in the preceding calc.		
Diff. of the dist., or apparent motion		36′ 20″			
Proper motion from the tab. for $9^h\ 25^m\ 28^s$		37′ 42″			
Fictitious parall., and at the same time that of the orbit		1′ 22″			

456

For the reduction to the vertical.

Mesolog. of the side C G, the parall. of the orbit	1′ 22″		783020
Ant. of the angle of the orb. and the vertical I C G	0 50″	found in calc. XIX.	11 *S.*
Mesolog. of C I, the parall. reduced to the vertical, becomes			783009 1′ 22″

455 set as above. The marks are printed after 21 10 30, 27 24 (′ ″) and 19 10 30, and as column heads over 15 26 22 and over 48 37 10; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 27 24. The page prints the antilogarithm 3.177 with a point, kept. The tags *A.* and *S.* and the point-letters are the page's own.

456 set unruled, in the page's own columns. The marks are printed after 19 10 30, after the time 9 25 28 (′ ″) and as column heads over 1 0 51; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 54 20, 36 20, 37 42 or 1 22. The page prints 54 20 for K E, where 20° 4′ 54″ less 19° 10′ 30″ gives 54′ 24″; the printed figures stand. The page prints 12.491, 3.177 and 15.668 with points, kept. The tag *A.* and the point-letters are the page's own.

457

[Margin: Parallaxis ad verticalem reducta.] *The parallax reduced to the vertical.*
For the prosth. of inclinat. of the first equat. for the later observ.

Parall. reduced to the vertical C I or C W	1′ 22″	Logarith. 783009	
Angle of inclin. D B C, found in the preceding calc.	46° 2′ 16″	Logarith. 32878 *A.*	
Prosth. of inclin. C W of the first equat., here Subt.		Logarith. 815887	0′ 59″ Subt.
	The parall. reduced to the vertical was		1′ 22″
	Vertical parall. equated a first time		23″

For the prosth. of inclin. of the second equat. C D.

Prosth. of inclin. of the first eq. C W	0′ 59″	Mesol. 815887	
Angle W C D from the preceding calc.	5° 21′ 0″	Antil. 437 *S.*	
Prosth. of inclin. of the sec. equat. C D		Mesol. 815450	0′ 59″ Subt.
	Parall. reduced to the vertical	1′ 22″	
	True vertical parall. equated a second time	23″	

458

For December 30, at 6^h 41^m 50^s in the evening, with the comet at an altitude of 70° 50′ 12″.

You see, then, that by this day the parallax has diminished remarkably: it now amounts to scarcely as many seconds as it was found to be minutes at the beginning. So it is concluded, not wrongly, that the parallax of our comet will soon, in the days that follow, gradually dwindle and vanish completely. But whether the matter stands entirely so or not, let us inquire with still more examples — namely for December 31, drawing it out from the distances of the comet and Capella. For since this fixed star lies almost at a right angle to the comet and its orbit, and the comet is receding from the fixed star, it can hardly

457 the marks are printed after both 1 22 and after 50 (″ only); the 0 before 50 carries no mark, and both stand as printed. The tag *S.* and the point-letters are the page's own.

458 set as above. The marks are printed after 1 22 in the first line and after each 0 59; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 22 or 23. *Subt.* is the page's own, kept. The tags *A.* and *S.* and the point-letters are the page's own.

fail that the parallax comes out still better and more accurately from distances of this kind than by the true and apparent motion.

[Margin: Parallaxis plùs plùsq́; attenuatur.] *The parallax is reduced more and more.*

Investigation of Parallax XXII, from the Distances of the Comet and Capella, Computed, for December 31 [Inveſtigatio Parallaxeos XXII. Ex diſtantiis Cometæ & Capellæ ſupputatis, ad diem 31 Decembris.]

1 Observ. d. 30 at	$6^h\ 10^m\ 30^s$ *vesp.*	Altitud. of the comet	66° 54′ 10″	Azim.	64° 44′ 10″ *Or. M.*
2 Observ. d. 31 at	$4^h\ 7^m\ 18^s$ *man.*	Altitud. of the comet	66° 50′ 20″	Azim.	42° 0′ 24″

459

[Margin: Figura H H.] *Figure H H.*

For the earlier distance, from the longit. and latitud.

Longitud. of the com.	21° 27′ 48″ ♉	Latit. of the com.	23° 23′ 17″ north	Latit. of Capell.	22° 52′ 15″ north
Longit. of Capell.	17° 0′ 12″ ♊	Compl.	66° 36′ 43″	Compl.	67° 7′ 45″
Angle	25° 32′ 24″				
Compl. of the latit. of Capell.	Log. 8188		Ant. 94509		
Angle	Log. 84132 *A.*				
Perpendic.	Log. 92320	23° 24′ 23″	Ant. 8587 *S.*		Ant. 8587
			Ant. 85922	64° 56′ 43″	
			Compl. of the lat. of the com.	66° 36′ 43″	
				1° 40′ 0″	Ant. 42 *A.*
			Earlier dist., apparent and true	23° 27′ 45″	Ant. 8629

460

[Margin: Diſtantia prior viſa & vera.] *The earlier distance, apparent and true.*

For the altitude and azim. of Capella, for the hour $4^h\ 7^m\ 18^s$.

[459] the marks are printed after 6 10 30 (′ ″), 66 54 10 and 64 44 10; the rest are supplied in the house form; no figure is supplied. *Or. M.* is the page's own tag, kept unexpanded.

[460] set as above. The marks are printed after 21 27 48, 23 23 17, 22 52 15, 23 24 23 and 64 56 43, and after 66 in the second line (° only); the rest are supplied in the house form; no figure is supplied. The signs ♉ and ♊ stand after the longitudes, as printed. The tags *A.* and *S.* are the page's own.

Right asc. of the midheaven	162° 59′ 12″						
Right asc. of Capell.	72° 46′ 0″ *S.*						
	90° 13′ 15″	Its compl. to 180° is					
Dist. from the merid.	89° 46′ 45″	Log. 1	E L				
Declin. of Capell. T E	45° 35′ 30″	Ant. 35701 *A.*		E S	Log. 33635		
	E F	Log. 35702	45° 35′ 28″		Ant. 33635		Ant. 33635
	Altit.	Antil. 20568 *S.*		S F	Ant. 0	0° 0′ 0″	
Azim. of Capell.	59° 16′ 0″	Log. of the azim. 15134		S A		35° 37′ 0″	
Azim. of the com.	42° 0′ 24″			A F		35° 37′ 0″	Ant. 20711
Differ.	17° 15′ 36″			A E or E K	Altit. of Capella	35° 30′ 9″	Log. 54346

461

[Margin: Altitudo Capellæ.] *Altitude of Capella.*

For the later distance, limited, of the com. and Capella, from the altit. and azim., for the hour 4^h 7^m 18^s on d. 31.

Complem. of the alt. of the com.	72° 21′ 55″	A I				
Refract. for 17° 18′	4′ 45″	Add. here				
Compl. of the alt. of the com., lim.	72° 26′ 30″	A I				
Compl. of the alt. of Capell.	54° 29′ 51″	Log. 20571 A E			Ant. 54347	
Angle from the azim. E A I	17° 15′ 36″	Log. 121499 Add.				
Perpendic. D E		Log. 142070	13° 58′ 39″		Ant. 3006 *S.*	
Antil. D I	5724				Ant. 51341	53° 14′ 26″ A D
Antil. D E	3006 Add.					72° 26′ 30″ A I
Antil. E I	8730	23° 35′ 40″	Dist. of the com. and Capell. after limit.			19° 12′ 4″ D I

[461] set unruled, in the page's own columns. The marks are printed after 162 59 12, 45 35 28, 59 16 0 and 0 0 0, and after 180; the rest are supplied in the house form; no figure is supplied. The page prints 90 13 15 where 162° 59′ 12″ less 72° 46′ 0″ gives 90° 13′ 12″; the printed figures stand. The tags *A.* and *S.* and the point-letters are the page's own.

462

For the reduction of the later distance and the exclusion of the proper motion.

Longitud of Capella	17° 0′ 12″ ♊				
Point of intersect. of the eclipt.	28° 34′ 48″ ♉	for d. 31 Decemb. *man.*			
Differ. G H	18° 25′ 24″	Ant. 5261			
Latit. of Capell.	22° 52′ 15″	Ant. 8188 *A.*		Log. 94505	
	Hyp. H E	Ant. 13449	29° 3′ 13″	Log. 72231 *S.*	
	Angle G H E		53° 9′ 35″	Log. 22274	
Angle of the orbit and the eclipt.	74° 3′ 53″	compl. to 180°	105° 56′ 7″		
	Remaining angle E H F		52° 46′ 32″	Log. 22780	
			H E	Log. 72231 *A.*	
	Dist. of Capella from the orbit E F			Log. 95011	22° 44′ 55″
	Later dist. E I	23° 35′ 40″		Log. 91564 *S.*	
			Of the angle F I E	Log. 3447	75° 2′ 30″
Proper motion from the tab. L I	0° 39′ 18″	Log. 447137		L I Ant. 6.534	
Of the angle F I E	75° 2′ 30″	Log., 3447 *A.*			
Perpend. L M		Log. 450584	37′ 58″	Ant. 6.098 *S.*	
Antil. E M	8601			I M Ant. 0.436	10′ 9″
Antil. L M	6.098 *A.*			Later dist. E I	23° 35′ 40″
Antil. E L	8607	23° 25′ 56″	E I, corr. and limit., the later dist.	E M	23° 25′ 31″
		23° 27′ 45″	The earlier dist. was E L		
Differ. of the dist., corr.		1′ 49″			

[462] set as above. The marks are printed after 72 21 55, 17 18 (° ′), 13 58 39, 53 14 26 and 23 35 40; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 4 45. The page prints 72 26 30 where 72° 21′ 55″ plus 4′ 45″ gives 72° 26′ 40″; the printed figures stand. *Add.* is the page's own, kept. The tag *S.* and the point-letters are the page's own.

463

[Margin: Figura H H.] *Figure H H.*

[Margin: Differentia Diſtantiarum.] *Difference of the distances.*

Since, however, this later distance, corrected and limited, is smaller than the earlier distance — although it was determined exactly, with the angle of the orbit and the point of intersection — whereas, on the contrary, that later distance ought to have been larger on account of the parallax. For at that time the comet was below Capella, and at the same time on one and the same vertical; and there, necessarily, if any parallax had been present, that distance would have appeared increased, according to axiom 5, p. 227.

Therefore no parallax any longer attaches to this observation, made on the 31st at $4^h\ 7^m\ 18^s$ with the comet at an altitude of 17° 18′ 5″; or at least no perceptible parallax can be inferred from these observations.

[Margin: Die 31 Dec. nulla ſenſibilis parallaxis Cometæ adfuit.] *On December 31 the comet had no perceptible parallax.*

But, you will say, what if something lies hidden in the refraction? For the larger the refraction applied to the comet, the larger too the parallax that comes out. This we certainly cannot deny at all. But whether or not some parallax underlies it here, we shall find out at once, by applying, namely, Tycho's refraction of the Moon to the later distance, for the limitation, so that it may become fully clear what is to be concluded on this matter altogether.

[Margin: Aliâ diverſâ indagine iterum tentatur, an aliqua hîc lateat parallaxis ?] *It is tested again, by another and different inquiry, whether some parallax lies hidden here.*

For the later distance, limited, of the comet and Capella, for the hour $4^h\ 7^m\ 18^s$.

Compl. of the altit. of the com. A I	72° 21′ 55″	
Tycho's refract. of the Moon	6′ 51″	Add. here, for 17° 18′ 5″
Compl. of the alt. of the com., lim., A I	72° 28′ 46″	
A D, however, was found	53° 14′ 26″	prec. page *S.*
Remaining D I	19° 14′ 20″	Antil. 5746
Perpendic. D E	13° 58′ 39″	Antil. 3006 *A.*

[463] set as above. The marks are printed after 17 0 12, 23 35 40 (the first), 0 39 18, 37 58 (′ ″) and 10 9 (′ ″), after 180, and as column heads over 29 3 13 and over 22 44 55; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 37 58, 10 9 or 1 49. The signs ♊ and ♉ stand after the longitude and the point of intersection, as printed. The page prints 6.534, 6.098 and 0.436 with points, and a low comma-like mark between Log. and 3447 in the angle's second line, kept. The tags *A.* and *S.* and the point-letters are the page's own.

	E I	Antil. 8752	23° 37′ 25″	Dist. of the com. and Capell., limit.	
Log. of the later dist. E I	23° 37′ 25″	Logar. 91448 *S.*			
Log. of the dist. of Capel. from the orbit	22° 44′ 55″	Logar. 95011			
Log. of the angle F I E		Logar. 3563	74° 47′ 45″		
Proper motion from the tab. L I	0° 39′ 18″	Logar. 447137		L I Antil. 6.534	
Of the angle F I E	74° 47′ 45″	Logar. 3563 *A.*			
Log. of the perpend. L M		Logar. 450700	37′ 56″	Ant. 6.088 *S.*	
Antil. E M	8622.222			I M Ant. 0.446	10′ 16″
Antil. L M	6.088 *A.*			Later dist. E I	23° 37′ 25″ limit.
Antil. E L	8628.310	23° 27′ 38″	Later dist., limit.	E M	23° 27′ 9″
The earlier dist. E L was		23° 27′ 45″			
Difference		7″			

464

Nevertheless, although the greatest refraction of all, namely Tycho's refraction of the Moon, was applied here, the later distance still came out smaller than the earlier by 7″. Therefore, according to axiom 5, there is no parallax in these observations for December 31; or at the very least none perceptible is detected.

[Margin: Parallaxis evaneſcere videtur.] *The parallax seems to vanish.*

But let us inquire further, with the help of other observations of December 31, whether there is any parallax at this time; and again partly from computed and partly from observed distances of the comet and Capella. First, namely, from the distance of the comet and Capella observed on the 30th at $6^h\ 41^m\ 50^s$, and from the other, later one, computed in the preceding calculation for $4^h\ 7^m\ 18^s$ on the 31st, so that any parallax that is present will show itself at once and with no great labour. For there is no need to compute the first distance, since it was observed. Indeed, even if you computed it from the altitudes at $6^h\ 41^m\ 10^s$ in the evening, it would still come out exactly the same, namely 23° 27′, as could easily be shown by the calculation itself, if we did not wish to spare paper.

[464] set unruled, in the page's own columns. The marks are printed after 72 21 55, 17 18 5, 23 37 25 (the first), 37 56 (′ ″) and 10 16 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 6 51, 37 56, 10 16 or 7. The page prints 6.534, 8622.222, 6.088, 0.446 and 8628.310 with points, kept. *Add.* is the page's own, kept. The tags *A.* and *S.* and the point-letters are the page's own.

Investigation of Parallax XXIII, from the Distances of the Comet and Capella, One Observed and the Other Computed and Limited by Refraction, for December 31 [Inveſtigatio Parallaxeos XXIII. Ex diſtantiis Cometæ & Capellæ, alterâ obſervatâ alterâ ſupputatâ, ac per refract. limitatâ Ad diem 31 Decemb.]

1 Obs. at the hour	$6^h\ 41^m\ 50^s$	Dist. of the comet and Capell., observ.	23° 27′ 0″ Parall.
2 Obs. at the hour	$4^h\ 7^m\ 18^s$	Dist. of the comet and Capell., computed, and limited by our refract., 4′ 45″, p. 257.	23° 25′ 56″ Vertic.
		Different.	1′ 4″

465

The later distance is therefore smaller than the earlier: so, according to the often-cited axiom 5, there is no parallax in the observations. But let us apply Tycho's refraction of the Moon, to see whether some parallax can be drawn out in this way.

Earlier distance, observed	23° 27′ 0″	
Later distance, limited by the refract. of the Moon, 6′ 51″	23° 27′ 38″	
Difference of the distances, or parall.	38″	fictitious.

466

Since, then, the later distance is larger than the earlier by 38″, some parallax, however very slight, certainly lies hidden here. This fictitious parallax should therefore be reduced to the vertical. For this we need both the altitudes and the azimuths, of the comet as well as of Capella, for the later observation, made at $4^h\ 7^m\ 18^s$, which have already been found in the preceding calculations.

[Margin: Veſtigium aliquod parallaxeos.] *Some trace of parallax.*

Azim. of the com., found in calc. XXI.	42° 0′ 24″	
Azim. of Capell., found in calc. XXIII.	59° 16′ 0″	
Angle C A E	17° 15′ 36″	Log. 121499
Compl. of the alt. of Capell., found in calc. XXIII.	54° 29′ 51″	Log. 20571 *A.*

[465] the marks are printed after 6 41 50 (′ ″), 23 27 0 and 4 45 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 4. *Parall.* and *Vertic.* name the parallel and the vertical observation, as on p. 321.

[466] set unruled, in the page's own columns. The marks are printed after 23 27 0 and after 6 51 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 38.

Perpendicular D E in Figure Ii.		Log. 142070			
Dist. of the com. and Capell., later, limit.	23° 27′ 38″	Log. 92101 *S.*			
Of the angle E C D		Log. 49969	37° 21′ 10″	Antil. 22952	
Of the side C G, the fictitious or mean parall.			38″	Mes. 859933 *S.*	
Of the parallax reduced to the vertical				Mes. 836981	0′ 48″

467

[Margin: Parallaxis ad vertical. reducta.] *The parallax reduced to the vertical.*

To find the prosthaphaeresis of inclination for the earlier observation, which was parallel to the horizon, we must compute the angle of inclination D B C, again with the help of the altitudes and azimuths. The comet's altitude and azimuth are indeed already given in investigation XIX; but those of Capella must now first be determined, namely for the hour $6^h\ 41^m\ 50^s$, following the construction of the diagram C c above.

[Margin: Figura Cc.] *Figure Cc.*

Right asc. of the midheaven	21° 10′ 30″	found in calc. XIX.			
Right asc. of Capella	72° 46′ 0″				
Dist. from the merid.	51° 35′ 30″	Log. 24385			
Declin. of Capell.	45° 35′ 30″	Log. 35701 *A.*		Log. 33635	
		Log. 60086	33° 15′ 11″	Ant. 17881 *S.*	Ant. 17881
Altitud.		Ant. 59441 *S.*		Ant. 15754	31° 19′ 27″
Az. of Cap., *Or. S.*	83° 30′ 0″	Log. 645		Compl. of the elev. of the pole	35° 37′ 0″
Az. of the com., *O. M.*	52° 13′ 40″				4° 17′ 33″ Ant. 281 *A.*
	135° 43′ 40″	whose compl. to 180°		Altit. of Capella	56° 30′ 15″ Log. 18162
is the angle B A C	44° 16′ 20″	Log. 35944			
Compl. of the alt. of the com.	19° 9′ 48″	Log. 111394 *A.*			

[467] set as above. The marks are printed after 42 0 24, and as column heads over 37 21 10 and over 0 48 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 38 or 0 48. The Roman numerals of the calculations are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

		Log. 147338			
Dist. of the com. and Capell.	23° 27′ 0″	Log. 92143 *S.*			
Angle A B C		Log. 55195	35° 9′ 26″	A B C	
Angle B A C	44° 16′ 20″	Log. 35944			
Compl. of the alt. of Capell.	33° 29′ 47″	Log. 59443 *A.*		Ant. 18161	
Perpend. D E		Log. 95387	22° 39′ 32″	Antil. 8032 *S.*	
Of the side E B		Log. 195470 + *S. Coss.*		Ant. 10129	25° 21′ 28″ E
Perpend. D E	22° 39′ 32″	Mes. 87354 +		Compl. of the alt. of Cap.	33° 29′ 47″ B
A E		Mes. 108116 —	71° 15′ 49″ D B A		8° 8′ 27″ E B
			35° 9′ 26″ A B C		
Of the angle of inclin.	36° 6′ 23″	Log. 52884 *A.*	36° 6′ 23″ D B C	Angle of inclin. of the first equat.	
Parall. reduced to the vertic.	0′ 48″	Log. 836981			
Prosth. of inclinat. of the first equat. C W		Log. 889865	0′ 28″	Subt., according to axiom 3, "In recession, above," etc.	
Parallax reduced to the vertical			48″		
Therefore the vertical parallax equated a first time			20″		

468

[Margin: Parallaxis primò coæquata.] *The parallax equated a first time.*

Although hardly any alteration can come to the parallax from the prosthaphaeresis of the second equation, let us nevertheless investigate it.

Dist. C B of the com. and Capell.	23° 27′ 0″	Log. 92143 *S.*			
Perp. E D, which equals B H	22° 39′ 32″	Log. 95387			
Angle B C D or B C H		Log. 3244	75° 29′ B C D		
Dist. C B of the com. and Capell.	23° 27′ 0″	Log. 92143		Mesol. 83523 + *S. Coss.*	
Angle of inclin. D B C	36° 6′ 23″	Log. 52884 *A.*			

[468] set as above. The marks are printed after 21 10 30, 44 16 20 (the first) and 180 (° only), and as column heads over 33 15 11, 31 19 27, 35 9 26, 25 21 20, 71 15 49 and 0 28 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 0 48, 0 28, 48 or 20. *Or. S.*, *O. M.* and *S. Coss.* are kept unexpanded, as printed; the signs + and — are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

Perpend. C W	Log. 145027	13° 34′	Mesol. 142167 +	
			Antil. 58644 +	56° 12′ B C W
Prosth. of inclin. C W	0° 0′ 28″ Mes. 889865 +			75° 29′ B C D
Angle of inclin. W C D	19° 17′ 0″ Antil. 5774 + *S.*		Angle of inclin.	19° 17′ W C D
Prosth. of inclin. of the second equat. C D	Mes. 884091 +	0′ 30″ *S.*		
	Parall. reduced to the vertical	0′ 48″		
Therefore the vertical parallax equated a second time		18″		

469

At the comet's altitude of 17° 38′ 5″, on December 31 at 4^h 7^m 18^s in the morning. Which was to be investigated.

Although it is clearly established from these two inquiries, made for December 31, that the parallax was very slight (for from calculation XXII none at all came out, and from this one, XXIII, a parallax of only 18″, at an altitude of about 17°), let us nevertheless pursue it more and more, from other, different observations, to see whether the matter really stands so. For in these last days of the apparition both skill and labour certainly failed in determining the parallaxes correctly by calculation: not only because they amounted to mere seconds, but above all because the comet was becoming smaller, fainter and lower, frequent changes of the air intervened, and, what matters most, it was not granted to observe it with suitable instruments in both quadrants.

[Margin: Quare ultimis diebus artis fuerit parallaxes rectè explorare.] *Why, in the last days, it was a matter of skill to determine the parallaxes correctly.*

Investigation of Parallax XXIV, from the Computed Distances of the Comet and Capella, Namely from the Altitudes and Azimuths, for December 31 [Inveſtigatio Parall. XXIV. Ex Diſtantiis Cometæ & Capellæ ſupputatis, & quidem ex altitud. & azimuthis, Ad diem 31 Decembris.]

1 Obs. d. 30 Dec. at 6^h 10^m 30^s *vesp.* Altit. of the com. 66° 54′ 10″ Azim. 64° 44′ 10″ *Or. M.* Parall.

469 set unruled, in the page's own columns. The marks are printed after 23 27 0 (both), 75 29 (° ′), 13 34 (° ′), 56 12 (° ′) and 0 30 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 0 30, 0 48 or 18; the page itself prints the leading 0 0 of 0 0 28. *S. Coss.* is kept unexpanded, as printed; the signs + are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

2 Obs. d. 31 Dec. at	$3^h\ 37^m\ 26^s$ *mat.*	Altit. of the com.		20° 27′ 54″	Azim.	46° 56′ 18″ *Occ. S.*	Vertic.

470

For the altitud. of Capella, for the hour $6^h\ 10^m\ 30^s$ in the evening.
[Margin: Figura C c.] *Figure C c.*

Right asc. of the midheaven	13° 19′ 53″						
Right asc. of Capell.	72° 46′ 0″						
Dist. from the merid.	59° 26′ 7″	Log. 14960					
Declin. of Capell.	45° 35′ 30″	Ant. 35701 *A.*		Log. 33635			
		Log. 50661	37° 3′ 7″	Ant. 22554 *S.*		Ant. 22554	
Altitud.		Ant. 48493 *S.*		Ant. 11081	26° 28′ 50″		
Azim. of Capel., *Or. S.*	78° 6′ 40″	Log. 2168		Compl. of the elev. of the pole	35° 37′ 0″		
Azim. of the com., *Or. M.*	64° 44′ 10″				9° 0′ 10″	Ant. 1277 *A.*	
	142° 50′ 50″	whose compl. to 180°,		Altit. of Cap.	51° 59′ 40″	Log. 23831	
is the angle E A I	37° 9′ 10″						

471

For the earlier distance of Capell. and the comet, for the hour $6^h\ 10^m\ 30^s$.
[Margin: Figura G G.] *Figure G G.*

Compl. of the altit. of the com.	23° 5′ 50″	Log. 93574		Ant. 8355			
Of the angle E A I	37° 9′ 10″	Log. 50428 *A.*					
Perpendic.		Log. 144002	13° 42′ 36″	Ant. 2890 *S.*		Ant. 2890	

470 the marks are printed after 6 10 30 (′ ″), 66 54 10 and 64 44 10; the rest are supplied in the house form; no figure is supplied. *Or. M.* and *Occ. S.* are the page's own tags, kept unexpanded. *Parall.* and *Vertic.* name the parallel and the vertical observation, as on p. 324.

471 set as above. The marks are printed after 13 19 53, 37 3 7 and 180 (° only), and as column heads over 26 28 50; the rest are supplied in the house form; no figure is supplied. The page prints 9 0 10 where 35° 37′ 0″ less 26° 28′ 50″ gives 9° 8′ 10″; the printed figures stand. *Or. S.* and *Or. M.* are kept unexpanded, as printed. The tags *A.* and *S.* and the point-letters are the page's own.

				Ant. 5465	18° 46′ 12″	
				Compl. of the alt. of Capel.	38° 0′ 20″	
					19° 14′ 8″	Ant. 5744 *A.*
				Dist. of the comet and Capella	23° 28′ 5″	Ant. 8634

472

For the altitude and azim. of Capella, for the hour 3^{h} 37^{m} 26^{s}. [Margin: Figura B B.] *Figure B B.*

Right asc. of the midheaven	155° 29′ 50″					
Right asc. of Capell.	72° 46′ 0″	*S.*				
Dist. from the merid.	82° 43′ 50″	Log. 817				
Declin. of Capell.	45° 35′ 30″	Ant. 35701 *A.*		Log. 33635		
		Log. 36518	43° 57′ 12″	Ant. 32864 *S.*		Ant. 32864
Altitud.		Ant. 25553 *S.*		Ant. 771	7° 6′ 10″	
Azim. of Capel., *Oc. S.*	63° 39′ 25″	Log. 10965		Compl. of the elev. of the pole	35° 37′ 0″	
Azim. of the com., *Occ. S.*	46° 56′ 18″				28° 30′ 50″	Ant. 12933 *A.*
Angle E A I	16° 43′ 7″			Altit. of Capella	39° 14′ 23″	Ant. 45797

473

[Margin: Altitudo Capellæ.] *The altitude of Capella.*

For the later distance, limit., of the com. and Capella, for the hour 3^{h} 37^{m} 26^{s}.

Compl. of the altitud. of the comet	69° 32′ 6″

[472] set as above. The marks are printed after 23 5 50 and 18 46 12; the rest are supplied in the house form; no figure is supplied. The tags *A.* and *S.* and the point-letters are the page's own.

[473] set unruled, in the page's own columns. The marks are printed after 155 29 50, and as column heads over 43 57 12 and 7 6 10; the rest are supplied in the house form; no figure is supplied. *Oc. S.* and *Occ. S.* are kept unexpanded, as printed. The tags *A.* and *S.* and the point-letters are the page's own.

Refract. from our table, add.	3′ 15″	at the altit. of the com.	20° 27′ 54″				
Compl. of the altit. of the com., limit.	69° 35′ 21″						
Compl. of the alt. of Capell.	50° 45′ 37″	Log. 25553		Ant. 45800			
Of the angle E A I	16° 43′ 7″	Log. 124594 *A.*					
Perpend. D E		Log. 150147	12° 52′ 26″	Ant. 2546 *S.*			Ant. 2546
			A D	Ant. 43254		49° 32′ 39″	
				Compl. of the alt. of the comet, limit. A I		69° 35′ 21″	
				D I		20° 2′ 42″	Ant. 6238 *A.*
				Dist. of the comet and Capella, limit.		23° 39′ 59″	Ant. 8784

474

For the angle F I E, for the reduction of the later dist., and for removing the proper motion.

[Margin: Figura X vel H H.] *Figure X or H H.*

Later dist., lim., E I	23° 39′ 59″	Log. 91276 *S.*					
Dist. of Cap. from the orb.	22° 44′ 55″	Log. 95011	found in calc. XXIII.				
Angle F I E		Log. 3735	74° 26′ 15″				
Proper mot. L I	35′ 43″	Log. 456697 *A.*		Ant. 5.397			
Perpend. L M		Log. 460432	34′ 24″	Ant. 5.006 *S.*			
Antil. E M 8662				Ant. 0.391	9′ 37″	I M	
Antil. L M 5 *A.*					23° 39′ 59″	E I, later dist., limit.	
Antil. E L 8667	23° 30′ 45″	later dist., reduct. and limit.			23° 30′ 22″	E M	
	23° 28′ 5″	is the earlier dist. found					
Fictitious parall.	2′ 40″						

[474] set as above. The marks are printed after 69 32 6, 20 27 54 and 50 45 37, and as column heads over 49 32 39; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 3 15. The tags *A.* and *S.* and the point-letters are the page's own.

475

[Margin: Parallaxis ficta.] *The fictitious parallax.*

Since, then, the later distance is greater than the earlier, a parallax is certainly to be expected here; but this fictitious parallax must be reduced to the vertical in the usual way, and in fact for the hour $3^h\ 37^m\ 26^s$ in the morning of the 31st, since the comet and Capella were then standing under the same vertical circle.

For the reduction to the vertical, for the hour $3^h\ 37^m\ 26^s$.

Angle C A E, found above from the azim.	16° 43′ 7″	Log. 124594			
Compl. of the altit. of Capell.	50° 45′ 37″	Log. 25553 *A.*			
Perpend. D E		Log. 150147			
Dist. of the com. and Capell.	23° 30′ 45″	Log. 91893 *S.*			
Angle E C D		Log. 58254	33° 57′ 3″	Ant. 18691 *S.*	
Of the side C G, the fictitious or mean parall.			2′ 40″	Mes. 716174	
Of the parallax reduced to the vertical				Mes. 697483	3′ 13″

476

[Margin: Figura B B.] *Figure B B.*

[Margin: Parallaxis ad vertical. reducta.] *The parallax reduced to the vertical.*

For the prosthaphaeresis of inclin. of the earlier observation; for the angle B A C has already become known from the difference of the azimuths of the comet and Capella, in the first part of this calculation.

[Margin: Figura C c.] *Figure C c.*

Angle B A C	37° 9′ 10″	Log. 50428		
Compl. of the altit. of the com.	23° 5′ 50″	Log. 93574 *A.*		
		Log. 144002		
Dist. of the com. and Capell.	23° 28′ 5″	Log. 92071 *S.*		
		Log. 51931	36° 30′ 26″ A B C.	
Of the angle B A C	37° 9′ 10″	Log. 50428		

[475] set as above. The marks are printed after 23 39 59 (the first), 74 26 15, 34 24 and 9 37; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 35 43, 34 24, 9 37 or 2 40. The decimal points of 5.397, 5.006 and 0.391 are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

[476] set as above. The marks are printed after 16 43 7 and 33 57 3, and as column heads over 3 13 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 40 or 3 13. The tags *A.* and *S.* and the point-letters are the page's own.

Compl. of the altit. of Capell.	38° 0′ 20″	Log. 48494 *A.*		Antil. 23832	
Perpend. D E		Log. 98922	21° 49′ 51″	Antil. 7441 *S.*	
Of the side E B	6° 5′ 20″	Log. 224365 + *S. Coss.*		Antil. 16391	31° 55′ 0″ A E
Perpendic. D E	21° 49′ 51″	Mes. 91481 +			38° 0′ 20″ A B
Of the angle D B A		Mes. 132884 —	75° 10′ 9″ D B A		6° 5′ 20″ E B
			36° 30′ 26″ A B C		
Angle of inclin.	38° 39′ 43″	Log. 47045 *A.*	38° 39′ 43″ D B C	Angle of inclinat. of the first equat.	
Parall. reduced to the vertic.	3′ 13″	Log. 697483			
		Log. 744528	2′ 1″ *S.* C W		
Parall. reduced to the vertical was			3′ 13″		
Therefore the vertic. parall. equated a first time			1′ 12″		

477

For the prosthaphaeresis of the sec. equat. B D.

[Margin: Figura C c.] *Figure C c.*

Dist. C B of the com. and Capell.	23° 28′ 5″	Log. 92071 *S.*			
Perp. E D, which equals B H	21° 49′ 51″	Log. 98922			
Angle B C D or B C H		Log. 6851	69° 2′ B C D		
Dist. C B of the com. and Cap.	23° 28′ 5″	Log. 92071		Mesol. 83443 + *S. Coss.*	
Angle of inclin. D B C	38° 39′ 43″	Log. 47045 *A.*			
Perpendic. C W		Log. 139116	14° 24′	Mes. 135963 +	
			B C W	Antil. 52520 +	53° 44′
Prosth. of inclin. C W	2′ 1″	Mes. 744528 +		B C D	69° 2′
Of the angle of inclin. W C D	15° 18′ 0″	Ant. 3609 + *S.*	W C D	Angle of inclinat.	15° 18′
Prosth. of inclin. of the second equat. C D		Mes. 740919 +	2′ 5″ *S.*		

[477] set unruled, in the page's own columns. The marks are printed after 37 9 10, 31 55 0 and 2 1 (′ ″), and as column heads over 36 30 26 and 75 10 9; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 3 13, 2 1 or 1 12. *S. Coss.* is kept unexpanded, as printed; the signs + and — are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

Prosth. reduced to the vertical	3′ 13″
Therefore the genuine vertical parallax equated a second time	1′ 8″

478

For December 31 at 3^h 37^m 26^s in the morning, with the comet at an altitude of 20° 27′ 54″.

[Margin: Parallaxis genuina, ad d. 31 Decemb.] *The genuine parallax, for December 31.*

Even though I am entirely certain that hardly any refraction other than the one assigned to it in the small refraction table applies to our comet, let us nevertheless work through this example too with the help of Tycho's lunar refraction: both so that it may be clear how much larger the parallax turns out, and so that no one may fail to see that, even with this refraction applied, the whole parallax can still hardly grow beyond 2 minutes.

This inquiry, however, will be carried out very easily this time, since only some parts of the earlier calculation change, while all the rest serve this one equally. So the earlier distance of the comet and Capella, for the hour 6^h 10^m 30^s, is kept; the later one, however, changes slightly by reason of the parallax, and consequently so do the angle F I E and likewise the fictitious parallax. But in the reduction to the vertical the same angle E C D remains, and so does the angle of the prosthaphaeresis of both the first and the second equation.

Investigation of Parallax XXV, from the Computed Distances of the Comet and Capella, Namely from the Altitudes and Azimuths, for December 31 [Inveſtigatio Parallaxeos XXV. Ex diſtantiis Cometæ & Capellæ ſupputatis & quidem ex altitud. & azimuthis, Ad diem 31 Decemb.]

1 Obs. d. 30 at	6^h 10^m 30^s	Distance of the comet and Capella	23° 28′ 5″	Parall.
2 Obs. d. 31 at	3^h 37^m 26^s.			

479

For limiting the later distance of the com. and Capell.

[Margin: Figura G g.] *Figure G g.*

478 set as above. The marks are printed after 23 28 5 (the first) and 2 5 (′ ″), and as column heads over 69 2 and 53 44 (° ′); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 2 1, 2 5, 3 13 or 1 8. *S. Coss.* is kept unexpanded, as printed; the signs + are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

479 the marks are printed after 10 30 (′ ″) and 23 28 5; the rest are supplied in the house form; no figure is supplied. *Parall.* names the parallel observation, as on p. 326.

Compl. of the altit. of the com. was	69° 32′ 6″			
Tycho's lunar refract.	5′ 15″	Add. at the altitud. of the comet	20° 27′ 54″	
Compl. of the alt. of the com., limit.	69° 37′ 21″	A I		
A D, however, was found	49° 32′ 39″	A D		
	20° 4′ 42″	D I	Antil. 6270	
		D E	Antil. 2546 *A.*	
		E I	Antil. 8816	23° 42′ 25″ Dist. of the com. and Capel.

480

Diagram. An engraved figure within one plate mark, with two drawings side by side. On the left, a spherical triangle with its apex A at the top and its base along the ecliptic; a star E on its left side is joined by straight and dotted lines to points near the right-hand arcs, and the comet's orbit is drawn as a line through two small circles. On the right, a circle crossed by the ecliptic, the equator, the horizon and the comet's orbit, with Capella marked as a star at E and the comet at C. Below the circle the plate carries an engraved date line and the engraver's note.

- A (apex of the left triangle): A
- inside the left triangle: H h (the figure's own designation)
- along the orbit line, upper part: Orbit [Orbita]
- along the same line, lower part: comet [?] (the ending of the word not read)
- points on the left drawing: M, L, D, K, E (a star), F
- along the base arc: Ecliptic [Ecliptica.]
- on the base arc: G, H, C, B
- on the rim of the circle: A (top), F, S, R, L, N, M, P
- at the end of the ecliptic line, above P: [?] (a glyph of a loop over an open curve, not read)
- along the line from P: Equator (its engraved initial not separated between Æ and A)
- beside the star E: Capella
- along the line through E: Ecliptic [Ecliptica.]
- along the line from M to L: Horizon [Horizon.]
- along the lower line: Orbita Cometæ.]
- in the lower part of the circle: West [Occidens.]; I i (the figure's own designation)

[480] set unruled, in the page's own columns. The marks are printed after 69 32 6, 20 27 54 and 23 42 25; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 5 15. The tag *A.* and the point-letters are the page's own.

- points inside the circle: E, D, I, G, C (a small circle with a point), K, O
- engraved line below the circle: On January 1 at 3^h 26^m 0^s in the morning [Die 1 Ian. Hor. 3 26′ 0″ m.]
- engraved at the lower right: The author engraved it [Autor ſculps.]

Labels not read: the glyph above P, and the ending of the word along the left orbit line.

For the angle F I E, and for eliminating the proper motion.

Later dist., limit., E I	23° 42′ 25″	Log. 91116 *S.*			
Dist. of Capell. from the orbit	22° 44′ 55″	Log. 95011			
Of the angle F I E		Log. 3895	74° 6′ 45″		
Proper mot. L I	35′ 43″	Log. 456697 *A.*		Antil. 5.397	
Perpendicul. L M		Log. 460592	34′ 21″	Antil. 4.992 *S.*	
Antil. E M 8692				Antil. 0.405	0° 9′ 46″ I M
Antil. L M 5				Later dist., limit.	23° 42′ 25″ E I
Antil. E L 8697	23° 33′ 5″	Later dist., limit. and reduced			23° 32′ 39″ E M
	23° 28′ 5″	is the earlier distance found			
Fictitious parallax	5′ 0″				

481

[Margin: Figura H h.] *Figure H h.*
For the reduction to the vertical.

Mesol. of the side C G, of the fictitious parall.	5′ 0″	653313	
Antil. of the angle E C D	33° 57′ 3″	18691 *S.*	
Mesol. of the parall. reduced to the vertical		634622	6′ 2″

482

[Margin: Figura B b vel I i.] *Figure B b or I i.*
For the prosthaph. of inclinat. of the first equat. Subt.

[481] set as above. The marks are printed after the first 23 42 25 (° ′ only), 74 6 45, 34 21, 0 9 46 and 23 33 5; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 35 43, 34 21 or 5 0; the page itself prints the leading 0 of 0 9 46. The decimal points of 5.397, 4.992 and 0.405 are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

[482] set as above. The marks are printed after 5 0 and 6 2 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 5 0 or 6 2. The tag *S.* and the point-letters are the page's own.

Parall. reduced to the vertical	6′ 2″	Logar. 634622	
Of the angle of inclin. D B C	38° 39′ 43″	Log. 47045 *A.*	
Prosth. of inclin. C W of the first equat.		Log. 681667	3′ 46″ *Subtr.*
		Parall. reduced to the vertical	6′ 2″
		Vertical parall. A D equated a first time	2′ 16″

483

[Margin: Figura C c.] *Figure C c.*
For the prosthaphaeresis of inclin. of the second equat.

Prosth. of inclin. of the first eq. C W	3′ 46″	Mesol. 681667	
Of the angle W C D, found to be	15° 18′ 0″	Antil. 3609 *S.*	
Prosth. of inclin. of the sec. equat. C D		Mesol. 678058	3′ 54″ *Subtr.*
		Parall. reduced to the vertical	6′ 2″
		Therefore the genuine vertical parallax equated a second time	2′ 8″

484

For December 31 at 3^h 37^m 26^s, with the comet at an altitude of 20° 27′ 54″.

[Margin: Quanta fuerit omnium maxima ad diem 31 Decemb.] *How great the largest of all was, for December 31.*

This, then, is the largest parallax of all that we have been able to derive for this December 31, although I am entirely of the opinion that hardly so great a one really existed at that time, as all the remaining investigations attest. So let whatever has been explored for this day, December 31, suffice; and let us at last turn to January 1 of the year 1653, making an effort to be able to explore the parallax of this day too. It will certainly be very difficult to investigate, both for the reasons given above and because no genuine vertical parallax can be investigated from our observations, but only the difference of the parallaxes between 22 and 20 degrees of the comet's altitude. Nevertheless it will be more

[483]set as above. The marks are printed after 6 2 (the first) and 3 46 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 6 2, 3 46 or 2 16. *Subtr.* and the caption's Subt. are kept unexpanded, as printed. The tag *A.* and the point-letters are the page's own.

[484]set unruled, in the page's own columns. The marks are printed after 3 46 and 3 54 (′ ″); the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 3 46, 3 54, 6 2 or 2 8. *Subtr.* is kept unexpanded, as printed. The tag *S.* and the point-letters are the page's own.

than sufficiently clear that the horizontal parallax of January 1 amounted to hardly, if even hardly, one whole minute.

First, let us set up the calculation from the distances of the comet and Capella; then from the distances of the comet and the bright star in the side of Perseus — and namely from longitudes and latitudes still to be computed, since at the time of observation only altitudes and azimuths were observed. Both observations, moreover, were made in the same western quarter, the earlier at $3^h\ 26^m\ 0^s$ and the later at $3^h\ 44^m\ 16^s$ in the morning; and both, too, almost under the same vertical. Here it should be noted that this time there is no need of refractions, since they have already been applied in the case of the longitudes and latitudes.

Investigation of Parallax XXVI, from the Computed Distances of the Comet and Capella, for January 1 [Inveſtigatio Parallaxeos XXVI. Ex diſtantiis Cometæ & Capellæ ſupputatis, ad diem 1 Januarii.]

1 Obs. d. 1 January, at	$3^h\ 26^m\ 0^s$ *man.*	alt. of the com.	21° 57′ 0″	azim.	46° 10′ *Occ. S.*	Vertical.
2 Obs. d. 1 January, at	$3^h\ 44^m\ 16^s$ *man.*	alt. of the com.	20° 4′ 30″	azim.	43° 9′ *Occ. S.*	Vertical.

485

For the earlier distance.
[Margin: Figura H h] *Figure H h.*

Long. of the com., 1st obs.	22° 44′ 45″	Latit. of the com.	25° 49′ 51″ *Bor.*	Latit. of Capell.	22° 52′ 15″ *Bor.*
Long. of Capell.	17° 0′ 12″	Compl.	64° 10′ 9″	Compl.	67° 7′ 45″
Of the angle E A L	26° 15′ 27″				
Compl. of the lat. of Capell., E A	Log. 8188		Ant. 94509		
Of the angle E A L	Log. 81552 *A.*				
Of the perpendicular E K	Log. 89740	24° 3′ 21″	Ant. 9085 *S.*		Ant. 9085.657
Antil.			Ant. 85424	64° 48′ 41″ A K	
			Compl. of the lat. of the com.	64° 10′ 9″ A L	
			L K	0° 38′ 32″	Ant. 6.282
		E L, earlier dist. of the com. and Capell.		24° 3′ 50″	Ant. 9091.939

[485] the marks are printed after 26 0 (′ ″), 21 57 0 and 46 10 (° ′); the rest are supplied in the house form; no figure is supplied. *man.* and *Occ. S.* are the page's own tags, kept unexpanded. *Vertical.* names the vertical observation, as on p. 326.

486

For the later distance.

Long. of the com., 2nd obs.	20° 43′ 42″ ♉	Latitude of the comet		25° 49′ 58″ *Bor.*	
Long. of Capell.	17° 0′ 12″ ♊	Compl.		64° 10′ 2″	
Angle E A I	26° 16′ 30″				
Compl. of the latit. of Capell.	Log. 8188	E A		Ant. 94509	
Of the angle E A I	Log. 81490 *Add.*				
Of the perpendicular E D	Log. 89678	24° 4′ 18″		Ant. 9098 *S.*	Ant. 9098
				A D Ant. 85411	64° 48′ 28″
				Compl. of the latitud. of the comet, A I	64° 10′ 2″
				I D	0° 38′ 26″ Ant. 6
		E I, later dist. of the com. and Capell.			24° 4′ 50″ Ant. 9104

487

For the equation of the later distance.

Long. of Capell., G	17° 0′ 12″ ♊			
Point of inters. of the eclipt., H	28° 39′ 0″ ♉			
Difference G H	18° 21′ 12″	Ant. 5221		
Latit. of Capell., E G	22° 52′ 15″	Ant. 8188	Of the latitude	Log. 94505
	Hyp. H E	Ant. 13409	29° 0′ 40″	Log. 72364 *S.*
		Angle G H E	53° 15′ 42″	Log. 22141

[486] set unruled, in the page's own columns. The marks are printed after 22 44 45, 25 49 51, 22 52 15, 24 3 21 and 64 48 41; the rest are supplied in the house form; no figure is supplied; the page itself prints the leading 0 of 0 38 32. The signs ♉ and ♊ (Taurus and Gemini) are the page's own; *Bor.* is kept unexpanded, as printed. The decimal points of 9085.657, 6.282 and 9091.939 are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

[487] set as above. The marks are printed after 20 43 42, 25 49 58, 24 4 18 and 64 48 28; the rest are supplied in the house form; no figure is supplied; the page itself prints the leading 0 of 0 38 26. The signs ♉ and ♊ are the page's own; *Bor.* and *Add.* are kept unexpanded, as printed. The tag *S.* and the point-letters are the page's own.

Compl. to 180° of the angle of the orb. and eclipt.		105° 48′ 0″		
	There remains the angle E H F	52° 32′ 18″	Log. 23097 *A.*	
		H E	Log. 72364	
	Dist. of Capella from the orbit of the comet, E F		Log. 95461	22° 38′ 26″ E F
	Later dist. E I of the com. and Cap.	24° 4′ 50″	Log. 89648 *S.*	
	Of the angle F I E		Log. 5813	70° 39′ 11″ F I E

488

Proper mot. from the table, L I	0° 1′ 13″	Log. 794646		Antil. 0.0062	
Of the angle F I E	70° 39′ 11″	Log. 5813 *A.*			
Of the perpendicular L M		Log. 800459	1′ 9″	Antil. 0.0056 *S.*	
Antil. E M 9100.165			I M	Antil. 0.0006	0° 0′ 22″
Antil. L M 0.006 *A.*				Later dist. E I	24° 4′ 50″
Antil. E L 9100.171	24° 4′ 28″	or E I corrected		E M	24° 4′ 28″
Earlier distance E L	24° 3′ 50″				
Differ. of the dist., or the parall.	38″	fictitious.			

489

[Margin: Parallaxis ficta.] *Fictitious parallax.*

Now, for reducing the parallax to the vertical, let the altitude and azimuth of Capella first be sought for each observation. Then from these, and from the altitudes and azimuths of the comet, let the angle E C D be sought — in the preceding Figure H h, the angle enclosed by the vertical circle A C and the line of distance E C — so that by means of this angle the parallax reduced to the vertical may come out.

For the altitud. of Capel. at 3^h 26^m 0^s

488 set unruled, in the page's own columns. The marks are printed after 17 0 12, 29 0 40, 22 38 29, 24 4 50 and the 180 of the compl. label; the rest are supplied in the house form; no figure is supplied. The signs ♊ and ♉ (Gemini and Taurus) are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

489 set as above. The marks are printed after 0 1 13, 1 9 (′ ″), 0 0 22 and the first 24 4 28; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 9 or 38; the page itself prints the leading 0 of 0 1 13 and of 0 0 22. The decimal points of 0.0062, 0.0056, 0.0006, 9100.165, 0.006 and 9100.171 are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

Right asc. of the Sun	282° 15′ 8″		
Elong. from the mer.	231° 30′ 0″		
Right asc. of the midheaven	153° 45′ 8″	360 degrees cast off	
Right asc. of Capell.	72° 46′ 0″		
Dist. from the mer.	80° 59′ 8″	Log. 1244	
Declin. of Capell.	45° 35′ 30″	Ant. 35701 *A.*	
Perpend. E F	43° 43′ 6″	Log. 36945	
Log. of the declin. of the star 33635			
Ant. of the perp. 32470 *S.*			Ant. 32470
Ant. S F 1165	8° 43′ 45″		
Compl. of the elev. of the pole, A S	35° 37′ 0″		
A F	26° 53′ 15″	Ant. 11440	
Altitude of Capella	40° 8′ 12″	Ant. 43910	
Log. of the perp. 36945			
Ant. of the alt. 26853 *S.*			
Log. of the azim. 10092	64° 41′ 25″	azim. of Capell.	
	46° 10′ 0″	azim. of the comet	
Angle C A E	18° 31′ 25″		

For the angle E C A or E C D.

Angle C A E	18° 31′ 25″	Log. 114667
Compl. of the altit. of the star	49° 51′ 48″	Log. 26853 *A.*
Perpend. D E		Log. 141520
Dist. of the com. and the star	24° 3′ 50″	Log. 89708 *S.*
Angle E C D	36° 33′ 27″	51812

490

For the altitud. of Capella at 3^h 44^m 16^s.

[Margin: Figura I i.] *Figure I i.*

282° 15′ 58″	Right asc. of the Sun
236° 0′ 0″	Elong. from the merid.
158° 15′ 58″	Right asc. of the midheaven
72° 46′ 0″	Right asc. of Capella.
85° 29′ 58″	Log. 309
45° 35′ 30″	Ant. 35701 *A.*

[490] the page sets this calculation, for the first observation, at the left, and the one below, for the second, beside it at the right; each is set unruled in its own columns. The marks are printed after 282 15 8, 8 43 45, 64 41 25 and the 18 31 25 of the angle line; the rest are supplied in the house form; no figure is supplied. "The star" renders the page's star sign, which stands for Capella. The tags *A.* and *S.* and the point-letters are the page's own; 51812 stands with no Log. before it.

Perpend. E F	Log. 36010	44° 14′ 6″	
Log. of the declin. 33635			
Ant. of the perp. 33340 *S.*			Ant. 33340
Ant. S F 295	4° 24′ 0″		
	35° 37′ 0″		
	31° 13′ 0″	Ant. 15640	
Altitude of Capella	37° 47′ 20″	Ant. 48980	
Log. of the perp. 36010			
Antil. of the alt. 23538 *S.*			
Log. of the azim. 12472	61° 58′ 27″	azim. of Capell.	
	43° 9′ 0″	azim. of the com.	
Angle C A E	18° 49′ 27″		

[Margin: Azimuth Capell. & Cometæ.] *Azimuth of Capella and of the comet.*
For the angle E C A or E C D.

Angle C A E	18° 49′ 27″	Log. 113114
Compl. of the altit. of the star	52° 12′ 40″	Log. 23537 *A.*
Perp. D E		Log. 136651
Dist. of the com. and the star	24° 4′ 20″	Log. 89676 *S.*
Angle E C D	38° 41′ 38″	Log. 46975

491

For the reduction to the vertical.

Mes. C G of the fictitious parall.	30″	859933
Ant. of the angle E C D	36° 33′ 27″	21909 *S.*
Mes. of the par. reduced to the vert.	0′ 47″ 18‴	838024

For the reduction to the vertical.

Mes. C G of the fictitious parall.	30″	859933	
Ant. E C D	38° 41′ 38″	24783 *S.*	
Mes. of the paral. reduced to the vertic.		835150	0′ 48″ 41‴
Parallax reduced to the vertic., the earlier			0′ 47″ 18‴
Therefore the difference of the parallax becomes			1″ 23‴
For January 1, namely, between the altitude of the comet			21° 57′ 0″

[491] set as above; the first six rows set the figures before their labels, as the page does. The marks are printed after 282 15 58, 44 14 6, 4 24 0 and the 18 49 27 of the angle line; the rest are supplied in the house form; no figure is supplied. "The star" renders the page's star sign. The tags *A.* and *S.* and the point-letters are the page's own.

	20° 4′ 30″
Different. of the altitud. of the comet	1° 52′ 30″

492

[Margin: Differentia parallaxium nondum duorum ſecundorum.] *The difference of the parallaxes not yet two seconds.*

It is therefore clear that this difference of the parallaxes is hardly perceptible, since it is only 1″ 23‴. So let us once more, as we have already indicated, seek the same difference of the parallaxes through the distances of the comet and the bright star in the side of Perseus, to see whether the same will come out here too. Since this fixed star likewise lies at roughly a right angle to the comet and its orbit, the operation is plainly the same as the earlier one, except that in this example the comet was approaching the bright star in the side of Perseus, whereas in the preceding inquiry it was receding from Capella. Hence it is not the later but the earlier distance that has to be corrected for the equation, although it appears smaller; for in the later distance the difference of the parallaxes really lay hidden. For that reason, too, the figures have to be changed.

Investigation of Parallax XXVII, from the Distances of the Comet and the Bright Star in the Side of Perseus, Computed for January 1 [Inveſtigatio Parall. XXVII. Ex Diſtantiis Cometæ & Lucid. later. Perſei ſupput. ad diem 1 Januarii.]

1 Obs. d. 1 Jan., at	$3^h\ 26^m\ 0^s$ *m.*	Alt. of the com.	21° 57′ 0″	Azim.	46° 10′ *Occ. S.*	Vertical.
2 Obs. d. 1 Jan., at	$3^h\ 44^m\ 16^s$ *m.*	Alt. of the com.	20° 4′ 30″	Azim.	43° 9′ *Occ. S.*	Vertical.

493

For the earlier distance.

Long. of the com., 1st obs.	22° 44′ 45″	Latit. of the com.	25° 49′ 51″ *Bor.*	Latit. of the side of Perseus	30° 5′ 30″ *Bor.*

[492] the page sets the first two calculations side by side, for the first observation at the left and the second at the right, each unruled in its own columns; the lines below the right half run on under it. The marks are printed after the 30 of both halves (″ only), 0 47 18 and 0 48 41 (′ ″ ‴) and 21 57 0; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 30, 0 47 18, 0 48 41 or 1 23; the page itself prints the leading 0 of 0 47 18 and 0 48 41. The tag *S.* and the point-letters are the page's own.

[493] the marks are printed after 26 0 (′ ″), 21 57 0 and 46 10 (° ′); the rest are supplied in the house form; no figure is supplied. *m.* and *Occ. S.* are the page's own tags, kept unexpanded. *Vertical.* names the vertical observation, as on p. 330.

Long. of the bright star in the side of Pers.	27° 1′ 12″ ♉	Compl.	64° 10′ 9″	Compl.	59° 54′ 30″
Diff. C G, or the angle	6° 16′ 27″				
	E A K				
Compl. of the latit. of the star, E A	Log. 14476		Antil. 69037		
Of the angle E A K	Log. 221479 *A.*				
Perpend. E K	Log. 235855	5° 25′ 34″	Antil. 449 *S.*	° ′ ″	Ant. 449
		A K	Antil. 68588	59° 45′ 31″	
		A L	Compl. of the latit. of the comet	64° 10′ 9″	
			K L	4° 24′ 38″	Ant. 296 *A.*
		Distance of the com. and the bright star in the side of Perseus		6° 59′ 0″	Ant. 745

494

[Margin: Diſtantia Cometæ & Stellæ.] *Distance of the comet and the star.*
For the later distance.

Long. of the com., 2nd obs.	20° 43′ 42″ ♓	Latitud. of the comet	25° 49′ 58″ *Bor.*		
Long. of the fixed star	27° 1′ 12″ ♉	Complem.	64° 10′ 2″		
Angle E A D	6° 17′ 30″				
Compl. of the latit. of the star, E A	Log. 14476		Antil. 69037		
Of the angle E A D	Log. 221101 *A.*				
Perpend. E D	Log. 235577	5° 26′ 27″	Antil. 451 *S.*	° ′ ″	Ant. 451
		A D	Antil. 68586	59° 45′ 29″	
		A I	Compl. of the latit. of the com.	64° 10′ 2″	
			D I	4° 24′ 33″	Ant. 296 *A.*

[494] set unruled, in the page's own columns. The marks are printed after 22 44 45, 25 49 51, 30 5 30 and 5 25 34; the cell ° ′ ″ is the page's own row of marks over the arc column below it; the rest are supplied in the house form; no figure is supplied. The sign ♉ (Taurus) is the page's own; *Bor.* is kept unexpanded, as printed. "The star" renders the page's star sign. The tags *A.* and *S.* and the point-letters are the page's own.

Distance of the comet and the side of Pers.	6° 59′ 40″	Ant. 747

495

For the equation of the earlier distance.

Long. of the fixed star, G	27° 1′ 12″ ♉				
Point of inters. of the eclipt., H	28° 39′ 0″ ♉				
Difference H G	1° 37′ 48″	Antil. 41			
Latit. of the bright star in the side of Perseus	30° 5′ 30″	Antil. 14476 *A.*	° ′ ″	Log. 69037	
	Hyp. H E	Antil. 14517	30° 8′ 6″	Log. 68908 *S.*	
		G H E Angle	87° 5′ 30″	Log. 129	
		Angle of the orbit and eclipt.	74° 12′ 0″		
		There remains the angle E H F	12° 53′ 30″	Log. 150010	
			H E	Log. 68908	
		Dist. of the fixed star from the orbit of the com., E F		Log. 218918	6° 25′ 49″
		Earlier dist.	6° 59′ 0″	Log. 210718 *S.*	
		Angle F I E		Log. 8200	67° 6′ 45″

496

[Margin: Diſtantia fixæ ab orbitâ.] *Distance of the fixed star from the orbit.*

Diagram. An engraved figure across the measure, with two drawings side by side. On the left, a narrow spherical triangle with its apex A at the top and its base along the ecliptic; the star at E, labelled as the bright star in the side of Perseus, is joined by dotted lines to D and to a small K, and by straight lines to two small circles near the arcs; a line labelled as the comet's orbit crosses the arcs from A. On the right, a circle crossed by lines labelled the ecliptic, the equator, the horizon and the comet's orbit, with the labelled star at E and a small circle at C. Below the circle the plate carries an engraved date line and the engraver's note.

[495] set as above. The marks are printed after 20 43 42, 25 49 58 and 5 26 27; the cell ° ′ ″ is the page's own; the rest are supplied in the house form; no figure is supplied. The sign ♉ is the page's own; *Bor.* is kept unexpanded, as printed. The tags *A.* and *S.* and the point-letters are the page's own.

[496] set unruled, in the page's own columns. The marks are printed after 27 1 12, 6 25 49 and 67 6 45; the cell ° ′ ″ is the page's own row of marks over the arc column below it; the rest are supplied in the house form; no figure is supplied. The sign ♉ (Taurus) is the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

- A (apex of the left drawing): A
- Along the line through the two small circles: Orbita Cometæ — *orbit of the comet*
- Beside the star, left: Luc. lat / Perſei. — *the bright star in the side of Perseus*
- E (the star): E
- K (small, between E and D): K
- D, F, I, L (on the right of the star, down the arcs): D, F, I, L
- Along the foot line: Ecliptica. — *ecliptic*
- Points on the foot line, left to right: H, G, C, B
- Below the left drawing: KK
- A (top of the circle): A
- S and F (on the circle, upper right): S, F
- On the circle, upper left: [?] (a looped sign, a script Q or an 8), and P
- Along the line from the upper-left sign: Ecliptica. — *ecliptic*
- Along the line from P: Æquator. — *equator*
- Beside the star inside the circle: Luc. lat [?] Perſ — *the bright star in the side of Perseus*
- E (the star), D and I (left of it), G (right of it), C (at a small circle, below): E, D, I, G, C
- R (on the circle, right): R
- M and L (ends of the horizon line): M, L
- Along the horizon line: Horizon. — *horizon*
- O and K (on the horizon line, at the foot of two arcs): O, K
- Lower left: T; Orbita Cometæ. — *orbit of the comet*; Occidens. — *west*; X
- N (on the circle, lower right): N
- Below the centre: LL
- Engraved line under the circle: Die Jan Hor. 3 26′ 0″ m. — *Day: Jan., at 3^h 26^m 0^s in the morning*
- Engraver's note: Autor ſculpſ. — *The author engraved it*[497]

Proper mot. from the table, L I	1′ 13″	Log. 794646		Ant. 0.0062	
Of the angle F I E	67° 6′ 45″	Log. 8200			
Perpendic. L M		Log. 802846	1′ 7″	Ant. 0.0053 *S.*	
Antil. E M 742.948			I M	Ant. 0.0009	0° 0′ 28″
Antil. L M 0.005 *A.*				Earlier dist. E I	6° 59′ 0″
Antil. E L 742.953	6° 58′ 32″	or E I corrected		E M	6° 58′ 32″
The later dist. was	6° 59′ 40″				
Differ. of the dist., or the parall.	1′ 8″	fictitious.			

[497]all 43 labels were read. The looped sign at the upper left of the circle is not separated between a script Q and an 8, and the vowel in the circle's star label between a and o. No day figure stands after "Die".

498

[Margin: Parallaxis ficta.] *Fictitious parallax.*

To reduce the fictitious parallax to the vertical, let the altitudes and azimuths of the bright star in the side of Perseus first be sought for each observation.

For the altitud. of the bright star in the side of Perseus at 3^h 26^m 0^s.

Right asc. of the midheaven	153° 45′ 8″	
Right asc. of the fixed star	43° 30′ 0″	
	110° 15′ 8″	its compl. to 180° is
Dist. from the merid.	69° 44′ 52″	Log. 6382
Declin. of the fixed star	48° 37′ 30″	Ant. 41404 *A.*
Perpend. E F	38° 19′ 27″	Log. 47786

For the altitud. of the bright star in the side of Perseus at 3^h 44^m 16^s.

158° 15′ 58″	Right asc. of the midheaven
43° 30′ 0″	Right asc. of the fixed star
115° 45′ 58″	
64° 14′ 2″	Log. 10473
48° 37′ 30″	Ant. 41404 *A.*
36° 31′ 47″	Log. 51877

499

Log. of the declin. of the star 28716			
Ant. of the perp. E F 24270 *S.*			Ant. 24270
Ant. S F 4446	16° 57′ 33″		
Compl. of the elev. of the pole, A S	35° 37′ 0″		
A F	52° 54′ 33″	Ant. 50569	
Altitude of the bright star in the side of Pers.	28° 14′ 16″	Log. 74839	
Log. of the perp. 47786			
Ant. of the altit. 12671 *S.*	° ′ ″		

[498] set as above. The marks are printed after 1 13 and 1 7 (′ ″), 0 0 28 and the first 6 58 32; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 13, 1 7 or 1 8; the page itself prints the leading 0 of 0 0 28. The decimal points of 0.0062, 0.0053, 0.0009, 742.948, 0.005 and 742.953 are the page's own. The tags *A.* and *S.* and the point-letters are the page's own.

[499] the page sets these two calculations side by side, for the first hour at the left and the second at the right, each unruled in its own columns; in the right half the figures stand before their labels, and its last four lines carry no label. The marks are printed after 153 45 8, 158 15 58 and the 180 of the complement line; the rest are supplied in the house form; no figure is supplied. The tag *A.* and the point-letters are the page's own.

Log. of the azim. 35115	44° 44′ 20″	Azimuth of the star
	46° 10′ 0″	Azimuth of the com.
Angle C A E in fig. L l.	1° 25′ 40″	

Log. of the declin. of the star 28716		
Ant. of the perp. E F 21874 *S.*	° ′ ″	Ant. 21874
Ant. S F 6842	20° 57′ 16″	
	35° 37′ 0″	
	56° 34′ 16″	Ant. 59619
Altitude of the bright star in the side of Pers.	26° 16′ 27″	Log. 81493
Log. of the perp. 51877		
Ant. of the alt. 10903 *S.*	° ′ ″	
Log. of the azim. 40903	41° 35′ 34″	Azimuth of the star
	43° 9′ 0″	Azimuth of the com.
Angle C A E	1° 33′ 26″	

500

[Margin: Azimuth Cometæ & Stellæ.] *Azimuth of the comet and of the star.*
For the angle E C A or E C D.

Angle C A E	1° 25′ 40″	Log. 369222
Compl. of the altit. of the star	61° 45′ 44″	Log. 12669 *A.*
Perpend. D E		Log. 381891
Dist. of the com. and the star	6° 59′ 0″	Log. 210718 *S.*
Angle E C D	10° 24′ 6″	Log. 171173

For the angle E C A or E C D.

Angle C A E	1° 33′ 26″	Log. 360646
Compl. of the alt. of the star	63° 37′ 33″	Log. 10992 *A.*
Perpend. D E		Log. 371638
Dist. of the com. and the star	6° 59′ 40″	Log. 210558 *S.*
Angle E C D	11° 31′ 16″	Log. 161080

500 these lines continue the two calculations begun at the foot of p. 333, for the first hour (first table) and the second (second table); the page sets them side by side, each unruled in its own columns. The marks are printed after 16 57 33; each cell ° ′ ″ is the page's own row of marks over the arc column below it; the rest are supplied in the house form; no figure is supplied. "The star" renders the page's star sign and "Stell."; "in fig. L l." renders the page's capital L followed by a small-capital L. The tag *S.* and the point-letters are the page's own.

501

For the reduction to the vertic.

Mes. C G of the fictitious parall.	1′ 8″	801741	
Ant. of the angle E C D	10° 24′ 6″	1657 *S.*	′ ″ ‴
Mes. of the parall. reduced to the vertic.		800084	1′ 9″ 8‴

For the reduction to the vertic.

Mes. C G of the fictitious parall.	1° 8″	801741	
Ant. of the angle E C D	11° 31′ 16″	2036 *S.*	′ ″ ‴
Mes. of the parall. reduced to the vertic.		799705	1′ 9″ 24‴
Parall. reduced to the vertic. for the earlier dist.			1′ 9″ 8‴
For d. 1 Jan., since the altitude of the comet, the earlier, was	21° 57′ 0″	–	16‴
the later	20° 4′ 30″		
	1° 52′ 30″		

502

[Margin: Differentia parallaxeos adhuc minor prodit.] *The difference of the parallax comes out still smaller.*

It is therefore apparent from this inquiry that this difference of the parallax comes out still a little smaller, only 16‴, so that it now vanishes entirely.

Finally, I would very gladly go further in the task we have undertaken, inquiring also whether any parallaxes are to be found for January 2, 3, 4 and 7. But in truth, however much I might wish it, it is still not possible to derive this from the observations of those days. For at that time, because of various obstacles, no observations of the kind required were obtained with suitable instruments, either the azimuthal quadrant or the sextant. And although on January 4 and 7 one or another observation of the comet was made with the sextant, yet, because the comet was then very faint, diminished in body, and also wrapped in refractions, those observations were not carried out accurately enough; hence nothing at all certain is promised from them either. It is better,

[501] set side by side on the page, the first hour at the left and the second at the right. The marks are printed after 1 25 40 and 1 33 26; the rest are supplied in the house form; no figure is supplied. "The star" renders the page's star sign. The tags *A.* and *S.* and the point-letters are the page's own.

[502] set side by side on the page, the first hour at the left and the second at the right; the lines below the right half run on under it, and the dash and the 16 stand on the line of the earlier altitude, under the columns of the reduced parallaxes. The marks are printed after 1 8 at the left (′ ″) and after 1 8 at the right, where the mark after the 1 is the degree mark (° ″); each cell ′ ″ ‴ is the page's own row of marks over the column below it; the mark is printed after 21 57 0; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 1 8, 1 9 8, 1 9 24 or 16. The tag *S.* and the point-letters are the page's own.

therefore, to pass over those observations, to stop at this first day of January, and to rest content with the parallaxes investigated by the method kept above — as indeed there is no one who may not rightly rest content with them: with those, namely, that were drawn out in the very extensive calculation above, with the greatest labour, greater indeed than you will perhaps believe.

[Margin: Quare parallaxis ad dies ſubſequentes Januarii, inveſtigari haud potuerit.] *Why the parallax could not be investigated for the following days of January.*

In future, however, when we undertake to examine the parallaxes by another method, we shall take pains that something certain may be drawn out for January 4, above all from the apparent and true altitudes of the comet. Without any doubt, though, just as on December 31 and January 1 all parallax was almost imperceptible, so too on the 4th we shall find hardly a trace of parallax.

[Margin: Autor exiſtimat Cometam die 4 Januarii nullam prorsùs posſedisſe parallaxin.] *The author judges that on January 4 the comet had no parallax at all.*

Before we come to the remaining methods of examining parallaxes, it will not be out of place to compute in advance, from each of the vertical parallaxes found above, the horizontal parallaxes, and to enter them in a table of their own. By their means it will become much clearer still to anyone how matters stood with those parallaxes, and in what way they decreased continuously from day to day. Moreover, you will also form from this a sounder judgement of what is to be decided about our observations, and about the method of calculation itself. Certainly anyone who examines the matter with a fair balance will marvel that almost all the operations agree so accurately, and at how we could have reached such precision: above all if one rightly weighs what it cost to obtain so many suitable observations from the sky itself — and that in such a comet, whose head was of rare size at the beginning and very small at the end, whose motion was very swift, but which was endowed with feeble light, and then was mostly very near the horizon and exposed to refractions, so that it could scarcely be seen with the naked eye, and by rather few.

[Margin: De parallaxibusCometæ horizontalibus.] *On the horizontal parallaxes of the comet.*

It would indeed not have been so hard to carry out observations of certain new stars and to derive parallaxes from them, since most of them abound in vigorous light and lack all motion whatever. So I cannot wonder enough how it came about that some mathematicians in the year 1572, in their observations of that new and by far most splendid star in Cassiopeia, could err so enormously. For either they lacked suitable and very large instruments, or the observers themselves are wholly to be accused of negligence: for in the space of about 15 months (so long did it stand constantly visible in the sky) they observed nothing certain and worth noting, as Tycho has sufficiently shown.

[Margin: Longè operoſius eſt, diverſitatem adſpectus in Cometis, quàm in novis Stellis deprehendere.] *It is far more laborious to detect the parallax in comets than in new stars.*

[Margin: Rationeparallaxeos circa novam Stellam 1572 nonnulli enormiter aberrarunt.] *In respect of the parallax, some erred enormously concerning the new star of 1572.*

Besides, it would have been far less work if I had chosen to investigate the parallaxes in the way that Brahe used for the comet of the year 1577 and Cysatus [Johann Baptist Cysat] for the comet of the year 1618. For neither of them, in even a single example of calculation, displayed to us demonstratively the pure vertical parallax of some definite altitude; instead they gave the difference of the parallax of two altitudes, and only as probable. [Margin: Faciliùs more Tychonico parallaxes inveſtigare.] *It is easier to investigate parallaxes in Tycho's manner.* Moreover, Tycho was never concerned, much less Cysat, that Scheat and the Mouth of Pegasus (from which they counted the distances) stood about 4, 5 or 6 degrees from the comet's orbit. And they took no account at all of whether the comet and the fixed star stood under one and the same vertical, or under very different verticals and at a very evident angle: indeed, even when, as mostly happened, they lay at an angle of 30 or 40 degrees, they still used no limitation or reduction at all. [Margin: Quâ ratione Tycho & Cyſatus parallaxes deduxerint.] *How Tycho and Cysat derived the parallaxes.* Hence, in that way, the difference of the parallaxes is indeed derived as probable by the mathematicians named above much more readily than the genuine vertical parallax of the comet is explored by us demonstratively, from almost every calculation; but, on the other hand (which I would wish said without prejudice to their reputation), their parallaxes did not come out so accurately: for, as is easily gathered, it was very easy for them to stray by one or two minutes. It would therefore have been better, in my judgement at least, if Tycho had chosen, for computing the parallaxes, fixed stars either nearest to the orbit, or placed at about a right angle to the comet and its orbit: for instance, the left hand of Antinous, the one in the head of

Equuleus, and above all Scheat (which star, with the comet, mostly stood in the earlier observation at a distance parallel to the horizon, and in the later observation vertical), and had carried out the calculation by our method. But since this method of ours for deriving parallaxes was not yet known at that time, and Tycho, besides, was hindered by other, weightier business and observations, he is easily excused here.

If this were the place for it, I would show how the genuine vertical parallaxes of the comet of the year 1577 can be examined from Tycho's own observations; but this business, as foreign to the matter, must be put off to another occasion. Let us return, then, to computing our horizontal parallaxes from whatever parallaxes of altitude were found above, so that it may be all the more evident in what way they changed and diminished continuously from December 23 to January 2, before we go on to examine the parallaxes by another, different method, as we promised at the beginning of this Book IV. But to save time, let us show by a single example only, from the first investigation, by what method these horizontal parallaxes were obtained, and let us enter the rest in a small

table, with all calculation omitted. Let the logarithm of the complement of the altitude, then, be subtracted from the logarithm of the parallax of the given altitude; from the remainder you will have the logarithm of the horizontal parallax sought. For example:

[Margin: Ex obſervationibus quoq́; Tychonianis parallaxes verticales Cometæ anni 1577 erui poſſunt.] *The vertical parallaxes of the comet of the year 1577 can also be drawn from Tycho's observations.*

[Margin: Ratio inveſtigandi parallaxes horizontal.] *The method of investigating horizontal parallaxes.*

In the first investigation the parall. of altitude was found for the altit. 44° 28′;

Its compl., namely	45° 32′ 0″	Logar. 33735 *S.*	
Parall. of the altit.	17′ 2″	Logar. 530740	
Parall. horizont. sought		Logar. 497005	23′ 52″

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In this way all the rest were computed, whatever the following small table contains. Its first column shows the order of the investigations; the second, from which distances the parallaxes were computed, whether from observed or from computed ones; the third, on what day and month, and the fourth, at what hour, minute and second the observations were taken; the fifth, at what altitude the comet then stood; the sixth shows the parallax of altitude found, and the seventh the horizontal parallax.

Horizontal parallaxes of the com. of the year 1652, derived from the parallaxes of altitude found above.

In-vesti-ga-tion	From which distances: whether observed or computed?	At what time they were taken: Day. Month.	H. Min. Sec.	Altitudes of the comet: Deg. Min. Sec.	Parall. of altitud.: M. Sec.	Parall. horiz.: M. Sec.
1.	Of the comet and the Heel,	23 Decemb.	$7^h\ 22^m\ 7^s$	44° 28′ 0″	17′ 2″	23′ 52″
	computed.		*v.* $10^h\ 57^m\ 20^s$			
			v.			
2.	Of the comet and Algol,	23 Decemb.	$7^h\ 22^m\ 7^s$	44° 28′ 0″	18′ 58″	26′ 34″
	computed.		*v.* $11^h\ 28^m\ 0^s$			
			v.			
3.	Of the comet and the Heel,	23 Decemb.	$7^h\ 22^m\ 7^s$	44° 28′ 0″	22′ 47″	31′ 55″
			v.			

[503] set unruled, in the page's own columns. The marks are printed after 44 28, 45 32 0 and 23 52; 17 2 is printed with none, and the marks there are supplied in the house form; no figure is supplied, and no degree figure stands before 17 2 or 23 52. The tag *S.* is the page's own.

In-vesti-ga-tion	From which distances: whether observed or computed?	At what time they were taken: Day. Month.	H. Min. Sec.	Altitudes of the comet: Deg. Min. Sec.	Parall. of altitud.: M. Sec.	Parall. horiz.: M. Sec.
	computed.	24 Decemb.	$1^h\ 27^m\ 30^s$ *m.*			
4.	Of the comet and Algol,	23 Decemb.	$7^h\ 22^m\ 7^s$ *v.*	44° 28′ 0″	17′ 23″	24′ 22″
	computed.	24 Decemb.	$1^h\ 27^m\ 30^s$ *m.*			
5.	Of the comet and Palilicium,	23 Decemb.	$7^h\ 22^m\ 7^s$ *v.*	44° 28′ 0″	16′ 52″	23′ 40″
	computed.	24 Decemb.	$1^h\ 27^m\ 30^s$ *m.*			
6.	Of the comet and Palilicium,	26 Decemb.	$9^h\ 0^m\ 34^s$ *v.*	67° 26′ 0″	6′ 59″	18′ 12″
	observed with the sext.		$10^h\ 13^m\ 30^s$ *v.*			

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[Margin: Parallaxes horizontales Cometæ an. 1652] *Horizontal parallaxes of the comet of the year 1652.*

In-vesti-ga-tion	From which distances: whether observed or computed?	At what time they were taken: Day. Month.	Hr. M. Sec.	Altitudes of the comet: Deg. M. Sec.	Parall. of altitud.: M. Sec.	Parall. horiz.: M. Sec.
7	Of the com. and Pal.: the one	26 Decemb.	$9^h\ 0^m\ 34^s$ *v.*	67° 26′ 0″	7′ 39″	19′ 56″
	observed, the other sought.		$11^h\ 38^m\ 22^s$ *v.*			
8	Of the comet and the Bright Star of Aries,	26 Decemb.	$9^h\ 0^m\ 34^s$ *v.*			
	computed.	27 Decemb.	$2^h\ 6^m\ 0^s$ *m.*	31° 12′ 13″	11′ 10″	13′ 3″
9	Of the comet and Capella,	26 Decemb.	$9^h\ 0^m\ 34^s$ *v.*			
	computed.	27	$2^h\ 6^m\ 0^s$ *m.*	31° 12′ 13″	7′ 51″	9′ 11″
10	Of the comet and Palilicium,	27 Decemb.	$2^h\ 6^m\ 0^s$ *m.*			
	observed with the sext.		$5^h\ 38^m\ 10^s$ *v.*	52° 17′ 7″	5′ 17″	8′ 38″
11	Of the comet and Palilicium,	27 Decemb.	$5^h\ 50^m\ 9^s$ *v.*	55° 6′ 0″	2′ 30″	4′ 5″

[504] the page rules seven columns; each entry stands on two printed lines, kept here as two rows. The third and fourth columns share one printed head, "At what time they were taken", over "Day. Month." and "H. Min. Sec.". In entries 1, 2 and 6 one date stands for both lines. The cells carry no marks; the marks are supplied in the house form, after the units the heads print (Gr. Mi. Sec., M. Sec.); no figure is supplied. *v.* and *m.* are the page's own tags on the times, kept unexpanded. Nothing is printed below the last entry.

Investigation	From which distances: whether observed or computed?	At what time they were taken: Day. Month.	Hr. M. Sec.	Altitudes of the comet: Deg. M. Sec.	Parall. of altitud.: M. Sec.	Parall. horiz.: M. Sec.
	computed.		$11^h\ 44^m\ 31^s$ *v.*			
12	Of the comet and the star at the hips	27 Decemb.	$5^h\ 50^m\ 9^s$ *v.*	55° 6′ 0″	2′ 7″	3′ 42″
	of Cassiop., comp.		$11^h\ 44^m\ 31^s$ *v*			
13	Of the comet and the Bright Star of Aries,	27 Decemb.	$5^h\ 40^m\ 48^s$ *v.*			
	observed with the sext.		$11^h\ 44^m\ 35^s$ *v.*	51° 52′ 40″	5′ 26″	8′ 48″
14	Of the comet and Capella,	27 Decemb.	$5^h\ 40^m\ 48^s$ *v.*			
	computed.		$11^h\ 44^m\ 35^s$ *v.*	51° 52′ 40″	3′ 49″	6′ 11″
15	Of the comet and Capella,	27 Decemb.	$5^h\ 35^m\ 6^s$ *v.*			
	taken with the sext.	28	$1^h\ 44^m\ 10^s$ *m.*	34° 36′ 17″	5′ 16″	6′ 24″
16	Of the comet and Capella,	28 Decemb.	$1^h\ 44^m\ 10^s$ *m.*	34° 36′ 17″	4′ 10″	5′ 4″
	taken with the sext.	29	$4^h\ 10^m\ 50^s$ *m.*			
17	Of the comet and Capella,	29 Decemb.	$4^h\ 10^m\ 50^s$ *m.*	16° 17′ 0″	5′ 26″	5′ 39″
	observed with the sext.	30	$6^h\ 41^m\ 50^s$ *v.*			
18	Of the comet and the Heel,	30 Decemb.	$6^h\ 10^m\ 30^s$ *v.*	66° 54′ 10″	0′ 28″	1′ 12″
	computed.	31	$3^h\ 37^m\ 26^s$ *m.*			
19	Of the comet and the Heel,	30 Decemb.	$6^h\ 41^m\ 50^s$ *v.*	70° 50′ 12″	1′ 2″	3′ 9″
	computed.	31	$3^h\ 37^m\ 26^s$ *m.*			
20	Of the comet and Algol,	30 Decemb.	$6^h\ 10^m\ 30^s$ *v.*	66° 54′ 10″	0′ 31″	1′ 19″
	computed.	31	$4^h\ 7^m\ 18^s$ *m.*			
21	Of the comet and Algol,	30 Decemb.	$6^h\ 41^m\ 50^s$ *v.*	70° 50′ 12″	0′ 23″	1′ 10″
	computed.	31	$4^h\ 7^m\ 18^s$ *m.*			
22	Of the comet and Capella,	30 Decemb.	$6^h\ 10^m\ 30^s$ *v.*			
	computed.	31	$4^h\ 7^m\ 18^s$ *m.*	17° 38′ 5″	0	0
23	Of the com. and Capella: the one	30 Decemb.	$6^h\ 41^m\ 50^s$ *v.*			
	computed, the other observed.	31	$4^h\ 7^m\ 18^s$ *m.*	17° 38′ 5″	0′ 18″	0′ 19″

Investigation	From which distances: whether observed or computed?	At what time they were taken: Day. Month.	Hr. M. Sec.	Altitudes of the comet: Deg. M. Sec.	Parall. of altitud.: M. Sec.	Parall. horiz.: M. Sec.
24	Of the comet and Capella,	30 Decemb.	$6^{h}\ 10^{m}\ 30^{s}$ *v.*			
	computed.	31	$3^{h}\ 37^{m}$	26♑ 20° 27′ 54″	1′ 8″	1′ 13″
			m.			
25	Of the comet and Capella,	30 Decemb.	$6^{h}\ 10^{m}\ 30^{s}$ *v.*			
	computed.	31	$3^{h}\ 37^{m}$	26♑ 20° 27′ 54″	2′ 8″	2′ 17″
			m.			
26	Of the comet and Capella,	1 January	$3^{h}\ 26^{m}\ 0^{s}$	21° 57′ 0″		
			m.			
	computed.		$3^{h}\ 44^{m}$	16♑ 20° 4′ 30″	1″ 23‴	
			m.			
27	Of the com. and the bright star in the side	1 January	$3^{h}\ 26^{m}\ 0^{s}$	21° 57′ 0″		
			m.			
	of Perseus, comp.		$3^{h}\ 44^{m}$	16♑ 20° 4′ 30″	0″ 16‴	
			m.			

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[Margin: Parallaxes horizontales Cometæ an. 1652] *Horizontal parallaxes of the comet of the year 1652.*

[Margin: Differentia Parallaxium.] *Difference of the parallaxes.*

From this table it is clear how the parallaxes of our phenomenon decreased from day to day, keeping a definite proportion, so that on about December 31 or January 1 they vanished almost entirely. [Margin: Initio Januarii parallaxis omninò evanuit.] *At the beginning of January the parallax vanished entirely.* But while you consider everything somewhat more deeply, weigh each of the investigations of the parallaxes carefully, and above all pick out the more certain parallaxes from the rest, which are less certain, you will find that on December 23 the horizontal parallax was scarcely 30 min., indeed somewhat less;

just as can be shown by four examples that agree almost to the very minutes: that on the 26th, in the evening, it did not exceed 19′, or 20′ at most; on the 27th, in the evening, it was scarcely 8′ or 9′; on the 28th, scarcely 5′ or 6′; on December 30, 2′ or 3′; on the 31st, 1′ at most; and on January 1 it was already imperceptible. From these, in their own place and time, for which they

[505] the table of p. 336 continues with its seven column heads set again, and no caption. Each entry stands on two printed lines, kept here as two rows. The third and fourth columns share one printed head, "At what time they were taken". In entries 7, 10–14 and 26–27 one date stands for both lines; in 9 and 15–25 the page prints two day numbers with one month name between them. In entries 7–25 the cells carry no marks, and the marks are supplied in the house form, after the units the heads print; in entries 26 and 27 the page itself prints ″ and ‴ over the two figures of the parallax of altitude, and leaves the last column blank. Entry 22 prints a single 0 in each parallax cell. The page writes the star of entries 8 and 13 with the sign ♈ (Aries). *v.* and *m.* are the page's own tags on the times, kept unexpanded; in entry 12 no point is seen after the second time's tag. No figure is supplied.

are reserved, we shall be able to derive demonstratively the true distance of the comet from the Earth that belongs to each day of the apparition. Before we undertake that, however, we shall investigate the parallaxes further, to see whether they really were as large as this or not, and indeed by the three different methods that follow.

[Margin: Diversâ methodo parallaxes inquirantur.] *Let the parallaxes be investigated by a different method.*

Now, then, let us first compute the vertical parallaxes by means of the apparent and the true altitudes, from certain observations suited to this business; for they cannot be derived from each and every one. For if the comet's apparent altitudes are either too near the meridian or remote from it, and likewise if the comet's azimuth was either too large or small, misshapen triangles are formed, so that the calculation cannot always agree even in the minutes themselves, let alone in the seconds. And hence it is most certain, as we have often said already, that the parallaxes can in no way at all be investigated from any and every observation, however supremely accurate, whatever method is adopted; rather, one must weigh carefully which observations suit this or that calculation. Otherwise you will surely labour in vain.

[Margin: Methodus Tychonis probabiliter tantùm parallaxes commonſtrat.] *Tycho's method shows the parallaxes only as probable.*

This method of ours, by the altitudes, will show the genuine parallaxes more truly than Tycho's, which its author himself mentions in book II on the comet of the year 1577, p. 134. For that method establishes only as probable that the comet moves above the Moon; ours, by contrast, exhibits the true vertical parallax of any given altitude, and consequently shows demonstratively the genuine distance from the Earth.

[Margin: Quid ſit parallaxis verticalis.] *What the vertical parallax is.*

For it is established from the doctrine of parallaxes that the vertical parallax is nothing but the difference between the apparent and the true place of the phenomenon, reckoned in the circle of altitude [circulus altitudinis], or vertical circle. Therefore, when the apparent and the true altitude of the comet are given together, their difference too becomes known, namely the pure vertical parallax sought itself. But you ask where these data are to be drawn from? I shall tell you: the apparent altitude from the observation; the true one, however, is elicited only by calculation, given, namely, the true declinations, right ascensions, longitudes and latitudes, which are to be taken from the table of the comet's true motion, or Ephemeris, constructed for each day of the whole apparition and for their quarters, and inserted at Sect. XI, Book I, p. 129. On what foundations these true motions of the comet were computed is set out in almost the whole of Book I, to which I refer the reader.

[Margin: Parallaxium calculus ex altitudinibus.] *Calculation of the parallaxes from the altitudes.*

Now I hasten to the calculation itself. Let the vertical parallax be sought, then, for December 24, in the morning, at $1^{h}\ 44^{m}\ 15^{s}$, at which time the apparent

altitude of the comet was observed to be 30° 53′ 0″. Let its true altitude for the same time be computed, given, namely, the right ascension of the Sun and the elongation from the meridian, and also the true declination and right ascension of the comet, taken from our Ephemeris just mentioned, but with the proportional part properly applied, wherever it is needed. Then from the true altitude found (which is always greater than the apparent one) let the apparent observed altitude be subtracted, and indeed after it has first been properly limited for refraction, if the comet's position so requires. The remainder is the pure vertical parallax at that same apparent altitude.

There is no need to say much about setting up the calculation itself, since enough has already been said above, at length and in several places, about finding the altitudes. So only the bare calculation will be given, with some necessary diagrams.

Diagram. An engraved figure across the measure: three circles side by side, each crossed by lines labelled as the ecliptic, the equator, the horizon and the comet's orbit, with a small circle at C marking the comet, a pair of letters inside, and an engraved line under it naming the calculations it serves. The left edge of the first circle runs into the gutter and is not seen.

- First circle, upper left: [?] (a looped sign, a script Q or an 8), and F
- First circle, top: A; upper right: S, G
- C (at the small circle, a dotted line from it up to F): C
- Along the line through C: Orbit. Cometæ — *orbit of the comet*
- Left: I
- Along the horizon line: Horizon. — *horizon*; L at its right end; O at the foot of an arc on it
- Along two lines descending to the right: Æquator. — *equator*; Ecliptica. — *ecliptic*; T and N at their ends
- Inside, lower left: MM
- Under the first circle: Pro Calculo 1; 2, 3. — *For calculations 1, 2, 3*
- Second circle, top: G, A; upper right: F (a dotted line from it down to C); upper left: S
- C (at the small circle): C
- Along a line rising to the right: Ecliptica. — *ecliptic*
- Right: I
- Ends of the horizon line: M (left), L (right); along it: Horizon. — *horizon*; O at the foot of an arc on it
- Lower left: Æquator. — *equator*
- Written upward along the line through C: Orbit. Comet. — *orbit of the comet*; X at its foot
- Inside, lower left: NN
- Under the second circle: Pro Calc. 4,5,6,7. — *For calcs. 4, 5, 6, 7*
- Third circle, top: A; upper right: S
- Along two lines descending to the right: Ecliptica. — *ecliptic*; Æquator. — *equator*

- C (at the small circle, a dotted line from it to F at the right): C, F
- Along the horizon line, left: Horizon. — *horizon*
- Along the orbit line: Orbita (at its left end) and Cometæ. — *orbit of the comet*
- O (at the foot of an arc from S): O; lower right: I
- Inside, lower left: Oo
- Under the third circle: Pro Calc. 8,9,10,11,12 — *For calcs. 8, 9, 10, 11, 12*
- Engraver's note: Autor fculps. — *The author engraved it*[506]

Calculation of the Parallaxes I, for December 24, at 1^h 44^m 15^s in the morning.

Right asc. of the Sun	273° 16′ 42″					
Elong. from the M.	206° 3′ 45″ *A.*					
Right asc. of the midheaven	119° 20′ 27	360 degrees cast off				
Right asc. of the comet	56° 49′ 44″					
Dist. from the merid.	62° 30′ 43″	Log. 11977				
Declin. of the com.	19° 0′ 4″	Ant. 5603 *A.*	° ′ ″	Log. 112212		
		Log. 17580	57° 0′ 57	Ant. 60796 *S.*	° ′ ″	Ant. 60796
				Ant. 51416	53° 16′ 21″	
					35° 37′ 8″	
					17° 39′ 13″	Ant. 4824 *A.*
				True altitude of the comet sought	31° 15′ 11″	Ant. 65620
				Apparent observed altitude of the comet	30° 53′ 0″ *S.*	Since this
				is smaller than the true one, the parall. therefore comes out as	22′ 11″	

[Margin: Parallaxis ad diem 24 Dec.] *Parallax for December 24.*

Calcul. of the Parall. II, for December 26, at 11^h 44^m 48^s in the evening.

[506] all 47 labels were read; the looped sign at the upper left of the first circle is not separated between a script Q and an 8. A label at the left edge of the first circle, in the gutter, would not be seen.

Right asc. of the Sun	276° 31′ 26″						
Elong. from the M.	176° 12′ 0″ *A.*						
Right asc. of the midheaven	92° 43′ 26″	360° cast off					
Right asc. of the com.	48° 6′ 34″						
Dist. from the M.	44° 36′ 52″	Log. 35334					
Declin. of the com.	32° 16′ 56″	Ant. 16791 *A.*	° ′ ″	Log. 62717			
		Log. 52125	36° 25′ 30″	Ant. 21738 *S.*	° ′ ″	Ant. 21738	
				Ant. 40979	48° 24′ 42″		
					35° 37′ 8″		
					12° 47′ 34″	Ant. 2513 *A.*	
				True altitude of the comet sought	51° 41′ 20″	Ant. 24251	
				Apparent observed altitude of the com.	51° 36′ 15″	Since this is smaller,	
				the parallax comes out as	5′ 5″		

[Margin: Parallaxis ad diem 26 Dec.] *Parallax for December 26.*

Calcul. of the parall. III, for the 26th, at 11^{h} 50^{m} 31^{s} in the evening.

Right asc. of the Sun	276° 31′ 44″					
Elong. from the M.	177° 37′ 45″ *A.*					
Right asc. of the midheaven	94° 9′ 29″	360° cast off				
Right asc. of the com.	48° 6′ 6″ *S.*					
Dist. from the M.	46° 3′ 23″	Log. 32837				
Declin. of the com.	32° 17′ 43″	Ant. 16805 *A.*	° ′ ″	Log. 62682		
		Log. 49642	37° 29′ 48″	Ant. 23145 *S.*	° ′ ″	Ant. 23145
				Ant. 39537	47° 40′ 4″	
					35° 37′ 8″	
					12° 2′ 56″	Ant. 2228 *A.*
				True altitude of the comet sought	50° 53′ 13″	Ant. 25373
				Apparent observed altitude of the com.	50° 44′ 0″	
				Parallax	9′ 13″	

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Calcul. of the Parall. IV, for the 27th, at 5^h 14^m 5^s in the evening.

Right asc. of the Sun	277° 19′ 58″						
Elong. from the M.	78° 31′ 15″ *A.*						
Right asc. of the midheaven	355° 51′ 13″						
Right asc. of the com.	46° 21′ 22″ *S.*	the compl. of this sum to 360 degrees					
Dist. from the M.	50° 30′ 9″	Log. 25922					
Declin. of the com.	34° 30′ 39″	Ant. 19355 *A.*	° ′ ″	Log. 56817			
		Log. 45277	39° 29′ 3″	Ant. 25903 *S.*	° ′ ″	Ant. 25903	
				Ant. 30914	42° 46′ 15″		
				Compl. of the elev. of the pole	35° 37′ 8″		
					7° 9′ 7″	Ant. 781 *A.*	
				True altitude of the comet sought	49° 58′ 40″	Ant. 26684	
				Apparent observed altitude of the com.	49° 51′ 0″		
				Parall.	7′ 40″		

[Margin: Parallaxis ad diem 27 Dec.] *Parallax for December 27.*

Calcul. of the Parall. V, for December 27, at 5^h 23^m 58^s in the evening.

Right asc. of the Sun	277° 20′ 23″						
Elong. from the M	80° 59′ 30″ *A.*						

[507] the page sets the three calculations unruled, in its own columns, and side by side: the first runs down the left and continues at the right beside the opening of the second, whose end stands at the right beside the opening of the third; the third ends at the right below. Each calculation is given here as one block, its rows in the order printed. The marks are printed after the Sun's right ascensions, the times of the captions and the 360 of the second and third calculations; the cells ° ′ ″ are the page's own rows of marks over the arc column below them; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 22 11, 5 5 or 9 13. The tags *A.* and *S.* are the page's own.

Right asc. of the midheaven	358° 19′ 53″					
Right asc. of the com.	46° 20′ 30″ *S.*	the compl. of this sum to 360 degrees				
Dist. from the M.	48° 0′ 37″	Log. 29671				
Declin. of the com.	34° 31′ 42″	Ant. 19376 *A.*	° ′ ″	Log. 56773		
		Log. 49047	37° 45′ 33″	Ant. 23498 *S.*		Ant. 23498
				Ant. 33273	44° 11′ 46″	
				Compl. of the elev. of the pole	35° 37′ 8″	
					8° 34′ 38″	Ant. 1125
				True altitude of the comet sought	51° 25′ 13″	Ant. 24623
				Apparent observed altitude of the com.	51° 16′ 8″	
				Parallax	9′ 13″	

Calcul. of the Parall. VI, for December 27, at 5^h 50^m 9^s in the evening.

Right asc. of the Sun	277° 21′ 39″					
Elong. from the M.	87° 32′ 15″ *A.*					
Right asc. of the midheaven	4° 53′ 54″	360 degrees cast off				
Right asc. of the com.	46° 17′ 57″					
Dist. from the M.	41° 24′ 3″	Log. 41351				
Declin. of the com.	34° 34′ 51″	Ant. 19438 *A.*	° ′ ″	Log. 56639		
		Log. 60789	32° 59′ 16″	Ant. 17580 *S.*		Ant. 17580
				Ant. 39059	47° 25′ 2″	
				Compl. of the elev. of the pole	35° 37′ 8″	
					11° 47′ 54″	Ant. 2135 *A.*
				True altitude of the comet sought	55° 11′ 33″	Ant. 19715
				Apparent observed altitude of the com.	55° 6′ 0″	
				Parallax	5′ 33″	

Calcul. of the Parall. VII, for December 27, at 11^h 44^m 31^s in the evening.

Right asc. of the Sun	277° 37′ 59″					
Elong. from the M.	176° 7′ 45″ *A.*					
Right asc. of the midheaven	93° 45′ 44″	360° cast off				
Right asc. of the com.	45° 46′ 23″ *S.*					
Dist. from the M.	47° 59′ 21″	Log. 29705				
Declin. of the com.	35° 15′ 14″	Ant. 20259 *A.*		Log. 54956		
		Log. 49964	37° 21′ 18″	Ant. 22955 *S.*		Ant. 22955
				Ant. 32001	43° 26′ 10″	
				Compl. of the elev. of the pole	35° 37′ 8″	
					7° 49′ 2″	Ant. 933 *A.*
				True altitude of the comet sought	51° 57′ 13″	Ant. 23888
				Apparent observed altitude of the com.	51° 52′ 40″	
				Parallax	4′ 33″	

Calcul. of the Parall. VIII, for December 31, at 3^h 37^m 26^s in the morning.

Right asc. of the Sun	281 [?] 8′ 20″					
Elong. from the M.	234° 21′ 30″					
Right asc. of the midheaven	155° 29′ 50″	360 degrees cast off				
Right asc. of the com.	40° 47′ 4″ *S.*					
Dist. from the M. *S.*	65° 17′ 14″	Log. 9605				
Declin. of the comet	41° 2′ 5″	Ant. 28195 *A.*		Log. 42080		
		Log. 37800	43° 15′ 14″	Ant. 31701 *S.*		Ant. 31701
				Ant. 10379	25° 39′ 25″	
				Compl. of the elev. of the pole	35° 37′ 8″	
					61° 16′ 33″	Ant. 73274 *A.*
				True altitude of the comet sought	20° 29′ 20″	Ant. 104975

				Apparent observed altitude of the comet	20° 23′ 30″	
				Parallax	5′ 50″	

[Margin: Parallaxis ad diem 31 Dec.] *Parallax for December 31.*[508]
Calcul. of the Parall. IX, for December 31, at 3^{h} 44^{m} 24^{s} in the morning.

Right asc. of the Sun	281° 8′ 39″					
Elong. from the M.	236° 6′ 0″				° ′ ″	
Right asc. of the midheaven	157° 14′ 39″	360 degrees cast off		Apparent alt.	19° 44′ 0″	
Right asc. of the com.	40° 48′ 24″			Refract.	3′ 30″ *S.*	
Dist. from the M. *S.*	63° 33′ 45″	Log. 11048		Corrected alt.	19° 40′ 30″	
Declin. of the com.	41° 2′ 28″	Ant. 28204 *A.*	° ′ ″	Log. 42066		
		Log. 39252	42° 28′ 56″	Ant. 30448 *S.*	° ′ ″	Ant. 77968
				Ant. 11618	27° 5′ 15″	
				Compl. of the elev. of the pole	35° 37′ 8″	
					62° 42′ 23″	Ant. 30448 *A.*
				True altitude of the comet sought	19° 45′ 58″	Ant. 108416
				Apparent alt., and corrected for refract.	19° 40′ 30″	
				Parall.	5′ 28″	

[Margin: Parallaxis ad diem 31 Decemb.] *Parallax for December 31.*
Calcul. of the Parall. X, for January 1, at 3^{h} 26^{m} 0^{s} in the morning.

[508] the page sets the five calculations unruled, in its own columns, and side by side, as on the page before: each begins at the left and continues at the right beside the opening of the next, and the eighth ends at the right below. Each calculation is given here as one block, its rows in the order printed. The marks are printed after the Sun's right ascensions, the times of the captions and the 360 of the seventh calculation; in the eighth the sort after 281 is not separated between a degree mark and a small a; the cells ° ′ ″ are the page's own rows of marks, printed in the fourth, fifth and sixth calculations only; the rest are supplied in the house form; no figure is supplied, and no degree figure stands before 7 40, 9 13, 5 33, 4 33 or 5 50. The tags *A.* and *S.* are the page's own; the fifth calculation's antilogarithm 1125 carries none, and the eighth's elongation none.

Right asc. of the Sun	282° 15′ 8″						
Elong. from the M.	231° 30′ 0″						
Right asc. of the midheaven	153° 45′ 8″			Apparent alt.	21° 57′ 0″		
Right asc. of the com.	39° 41′ 17″			Refract.	2′ 25″ *S.*		
Dist. from the M. *S.*	65° 56′ 9″	Log. 9096		Corrected alt.	21° 54′ 25″		
Declin. of the com.	42° 20′ 27″	Ant. 30224 *A.*	° ′ ″	Log. 39521			
		Log. 39320	42° 26′ 48″	Ant. 30392 *S.*	° ′ ″	Ant. 30392	
				Ant. 9129	24° 6′ 45″		
				Compl. of the elev. of the pole	35° 37′ 8″		
					59° 43′ 53″	Ant. 68505 *A.*	
				True altitude of the comet sought	21° 50′ 12″	Ant. 98897	
				Apparent alt. corr. for refract.	21° 54′ 25″	Since this	
				is greater than the true one, no parallax is therefore given here.			

[Margin: Die 1 Januarii nulla reperitur parallaxis.] *On January 1 no parallax is found.*

Calcul. XI of the Parall., for January 1, at $3^h\ 44^m\ 16^s$ in the morning.

Right asc. of the Sun	282° 15′ 58″						
Elong. from the merid.	236° 0′ 0″						
Right asc. of the mid-heaven	158° 15′ 58″	360° cast off		Apparent alt.	20° 4′ 30″	Ap-par-ent alt.	20° 4′ 30″
Right asc. of the com.	39° 40′ 25″			Our refr.	3′ 30″	Tycho's refr.	3′ 30″
Dist. from the M. *S.*	61° 24′ 13″	Log. 13006		Apparent corr.	20° 1′ 0″	Corr. ap-par-ent	19° 59′ 0″

Declin. of the com.	42° 21′ 27″	Ant. 30251 *A.*	° ′ ″	Log. 39489			
		Log. 43257	40° 27′ 33″	Ant. 27320 *S.*		° ′ ″	Ant. 27320
				Ant. 12169		27° 41′ 40″	
				Compl. of the elev. of the pole		35° 37′ 8″	
						63° 18′ 48″	Ant. 80050 *A.*
				True altitude of the comet sought		19° 59′ 0″	Ant. 107370
				Apparent alt. of the com., our corr.		20° 1′ 0″	But since this
				is greater than the true alt., no parall. is therefore found; indeed, even if we apply Tycho's refraction, still no parallax at all comes out. Apparent alt.		19° 59′ 0″	
				Corrected alt.		19° 59′ 0″	
						0″ [?]	

Calculation XII of the Parall., for January 4, at 2^h 39^m 10^s in the morning.

Right asc. of the Sun	285° 31″ 5″						
Elong. from the merid.	219° 47′ 30″						
Right asc. of the com.	145° 18′ 35″						
Right asc. of the midheaven	36° 59′ 35″						
Dist. from the M. *S.*	71° 41′ 0″	Log. 5199					
Declin. of the com.	45° 22′ 45″	Ant. 35323 *A.*	° ′ ″	Log. 34043			
		Log. 40522	41° 49′ 24″	Ant. 29409 *S.*		° ′ ″	Ant. 29409
				Ant. 4634		17° 18′ 33″	
				Compl. of the elev. of the pole		35° 37′ 8″	
						52° 55′ 41″	Ant. 50612 *A.*
				True altitude of the comet sought		26° 41′ 39″	Ant. 80021
				Apparent observed altitude of the comet		26° 41′ 25″	
				Parallax		14″	

[Margin: Parallaxis diei 4 Januarii.] *Parallax of January 4.*[509]

From these twelve very different investigations it is clearly evident of what kind and how great the comet's vertical parallaxes come out by the method just set out: namely, that they agree quite precisely with the others, derived from the distances.

And although they might at times disagree by a minute or so, it would still not follow from this that the comet did not remain in the highest aether, as we have proposed to say more fully below, in its proper place; especially since the parallaxes just found turn out to be somewhat smaller still than the earlier ones. But so that anyone may judge this very point the more accurately, as if at a single glance, we shall likewise compute the horizontal parallaxes from these parallaxes of altitude and, leaving out all the calculation, enter them in the table adjoined.

Vertical and Horizontal Parallaxes of the Comet, derived from the apparent and true altitudes.

Calculation	At what time they were taken by observation: Day, Month	Hour, Min., Sec.	Altitudes of the comet (Deg., Min., Sec.)	Parall. of altitude (Min., Sec.)	Horizontal parall. (Min., Sec.)
1.	December 24	$1^h\ 44^m\ 15^s$ *m.*	30° 53′ 0″ apparent	22′ 11″	25′ 51″
			31° 15′ 11″ true		
2.	December 26	$11^h\ 44^m\ 48^s$ *v.*	51° 36′ 15″ apparent	5′ 5″	8′ 11″
			51° 41′ 20″ true		
3.	December 26	$11^h\ 50^m\ 31^s$ *v.*	50° 44′ 0″ apparent	9′ 13″	14′ 34″
			50° 52′ 55″ true		
4.	December 27	$5^h\ 14^m\ 5^s$ *v.*	49° 51′ 0″ apparent	7′ 40″	11′ 54″
			49° 48′ 40″ true		

[509] the page sets the four calculations unruled, in its own columns, and side by side, as on the pages before: each begins at the left and continues at the right beside the opening of the next, and the twelfth ends at the right below. Each calculation is given here as one block, its rows in the order printed; the short blocks of apparent altitude, refraction and corrected altitude that stand at the right beside the openings of the ninth, tenth and eleventh calculations are set in the rows beside which they stand, and in the eleventh the two such blocks, our own refraction and Tycho's, stand side by side, as on the page. The sentence of the tenth calculation is printed after its last altitude and runs on below it; that of the eleventh likewise, ending with an apparent and a corrected altitude and a 0 below them. The marks are printed after the Sun's right ascensions, the times of the captions, the apparent altitudes of the tenth and eleventh calculations' refraction blocks and the 360 of the eleventh; in the twelfth the mark after the Sun's 31 is double, as printed; the cells ° ′ ″ are the page's own rows of marks; the rest are supplied in the house form, and the point printed after the ninth calculation's 27 is not carried. No figure is supplied, and no degree figure stands before 3 30, 2 25, 5 28, 5 30 or 14. The tags *A.* and *S.* are the page's own; the eleventh calculation's refractions carry none; the 0 that closes the eleventh is followed by a mark that is not settled.

Cal-cula-tion	At what time they were taken by observation: Day, Month	Hour, Min., Sec.	Altitudes of the comet (Deg., Min., Sec.)	Parall. of altitude (Min., Sec.)	Horizontal parall. (Min., Sec.)
5.	December 27	$5^{h}\ 23^{m}\ 58^{s}$ *v.*	51° 16′ 0″ apparent	9′ 13″	14′ 44″
			51° 25′ 13″ true		
6.	December 27	$5^{h}\ 50^{m}\ 9^{s}$ *v.*	55° 6′ 0″ apparent	5′ 33″	9′ 42″
			55° 11′ 33″ true		
7	December 27	$11^{h}\ 44^{m}\ 31^{s}$ *v.*	51° 52′ 40″ apparent	4′ 33″	7′ 22″
			51° 57′ 13″ true		
8	December 31	$3^{h}\ 37^{m}\ 26^{s}$ *m.*	20° 23′ 30″ apparent	5′ 50″	6′ 13″
			20° 29′ 20″ true		
9	December 31	$3^{h}\ 44^{m}\ 24^{s}$ *m.*	19° 40′ 30″ apparent	5′ 28″	5′ 48″
			19° 45′ 58″ true		
10	January 1	$3^{h}\ 26^{m}\ 0^{s}$ *m.*	21° 54′ 25″ apparent	0′ 0″	0′ 0″
			21° 50′ 12″ true		
11	January 1	$3^{h}\ 44^{m}\ 0^{s}$ *m.*	20° 1′ 0″ apparent	0′ 0″	0′ 0″
			19° 59′ 0″ true		
12	January 4	$2^{h}\ 39^{m}\ 10^{s}$ *m.*	26° 41′ 25″ apparent	0′ 14″	0′ 16″
			26° 41′ 39″ true		

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[Margin: Parallaxes Verticales & horizontales Cometæ 1652.] *Vertical and horizontal parallaxes of the comet of 1652.*

From these very many investigations, then, about 40 in number, made by the distances as well as by the altitudes, I believe that everyone who loves the truth now gathers more than enough to see how matters stand, all in all, with the true parallaxes of our comet; and that, from these horizontal parallaxes, they amply suffice both to demonstrate in due course to all the Peripatetics the true distance of the comet from the Earth, for any day of the whole apparition as well, and to settle completely those very bitter disputes among those of whom some contend that the comet is aethereal and others that it is sublunary. But to fulfil our promise, and to give this matter more and more satisfaction, let us

510a ruled, boxed table of six columns under a caption. The head "Quo tempore observat. fuerint habitae" runs across the day column and the time column; the unit rows (Day, Month; Hour, Min., Sec.; Deg., Min., Sec.; Min., Sec.) are the page's own, set in the house form in the cells. Each calculation takes two printed lines, the apparent altitude above and the true below, with the number, date, time and both parallaxes standing between them; they are given here as two rows, with those cells in the first. The row numbers 1–6 carry a point and 7–12 none, as printed; the time tags *m.* and *v.* are the page's own; the figures 0 before 14 and 16 in the last row, and every 0 in rows 10 and 11, are printed; no figure is supplied.

examine those parallaxes in yet another way, namely from the apparent and true declinations and latitudes. How this investigation ought to be set up must now be told; for, as far as I know, it has not until now been sufficiently discovered.

[Margin: Vera diſtantia Cometæ à Terrâ abundènunc demonſtrata eſt.] *The true distance of the comet from the Earth has now been amply demonstrated.*

[Margin: Deparallaxibus ex declinationibus & latitud. erutis.] *On parallaxes derived from the declinations and latitudes.*

Just as the difference between the true and the apparent place in the vertical circle shows the vertical parallax itself, so likewise the true and the apparent declination show the same parallax: namely when, as happened in our phenomenon, its orbit intersects the equator and the ecliptic at a fairly obtuse angle, that is, when the comet is carried by its proper motion roughly either from south to north or from north to south; but only from those observations made around the meridian and the nonagesimal. Otherwise, namely when the comet's orbit describes some circle nearly parallel to the equator or the ecliptic, and the comet stands too far from the meridian and the nonagesimal, then parallaxes are certainly in no way explored by this method. The former indeed always actually held for our comet: its orbit passed over both the equator and the ecliptic at a very wide angle. But as for the latter, very few observations around the meridian [Meridiem] and the nonagesimal came our way; hence also only very few parallaxes can be drawn out by this method.

The reason why parallaxes cannot be deduced from positions of the comet too far removed from the meridian and the nonagesimal is this: the angle of the vertical and the declination (as is evident from the figure), and likewise that of the vertical and the latitude, become larger the farther the comet is removed from the meridian or the nonagesimal; and the larger these angles are, the less accurately the parallaxes come out; and then they always turn out smaller than the proper ones. But the nearer the phenomenon is to the meridian and the nonagesimal, the more acute the angles become, so that at the meridian or the nonagesimal itself the said angles vanish entirely, and the vertical circle coincides completely with the circle of declination, as does the vertical circle with that of latitude; and then the difference of the true and the apparent declination is itself the true vertical parallax. The same is also to be understood of the latitudes near the nonagesimal.

Diagram. An engraved figure in a light plate-mark, standing at the right of the measure beside the paragraph above. A large circle, with a smaller circle at its upper left passing through E and B. A horizon line runs across it from M at the left to L at the right, lettered "Horizon." above it at the left. A straight line lettered "Æquator." (the equator) rises from O at the lower left to P at the upper right, and a curve lettered "Ecliptica." (the ecliptic) rises from N at the lower left towards the upper right. From A at the top, arcs descend to three points K on the horizon, and lines run from B towards the right. Three small circles on the arcs are lettered C; D and H stand on or beside the equator line below them. A further letter stands at the right of the uppermost C, at the end of a

short line drawn to the outer circle; its engraved form is not separated between Q and g. At the lower right stands the engraver's signature, "Aut. fculps." (the author engraved it).

- E (top of the small circle): E
- A (top of the large circle): A
- B (rim of the small circle, left): B
- C (three small circles on the arcs: upper right, middle, left): C, C, C
- Right of the uppermost C: [?] (Q or g; not separated)
- P (upper right, end of the equator line): P
- D (three, on or near the equator line): D, D, D
- H (three, on or beside the equator line): H, H, H
- K (three, on the horizon): K, K, K
- L (right end of the horizon): L
- M (left end of the horizon): M
- Horizon. (left, above the horizon line): the horizon
- Ecliptica. (along the curve): the ecliptic
- Æquator. (along the straight line): the equator
- O (lower left, start of the equator line): O
- N (lower left, start of the ecliptic): N
- Aut. fculps. (lower right): the author engraved it

But if no observations of comets are available so precisely around the meridian and the nonagesimal, you may indeed also bring somewhat more remote ones into the calculation and, by means of the angle of the vertical and the declination, reduce the fictitious parallax — that is, the difference of the apparent and the true declination — to the vertical one, provided the said angle is not too obtuse. I would have you note this well. Before we set out the calculation itself, however, I shall give two axioms, with whose help you can understand with almost no trouble whether any parallax is to be presumed from those observations.

Axioms of Parallaxes [Axiomata Parallaxium.]

1. If the declinations and latitudes are southern, the true ones are always smaller than the apparent ones; provided, that is, that some parallax inheres in the observations.

[Margin: Axiomata parallaxium.] *Axioms of parallaxes.*

2. But if the declinations and latitudes are northern, the true ones are always greater than the apparent ones, if some parallax underlies them; if there is none, you will find the contrary.

Let the parallax first be sought for December 23 at 7^{h} 22^{m} 7^{s} in the evening. At that time, from our table inserted on p. 129, there is found:

Apparent declination	17° 2′ 26″	*Bor.*
True declination	17° 21′ 26″	from our Ephem., Sect. XI, Book I, p. 129.
Differ.	19′ 0″	or the fictitious parall.

Since, therefore, the true declination is greater than the apparent, a parallax is certainly given. Let the angle of the vertical and the declination, *h c d*, therefore be sought, as we showed on p. 189 — although this time there is no need to investigate it, since it has already become known in the first investigation of the parallax, on p. 190. The whole calculation is therefore easily completed in the following way.

Mesol. of the fictitious parall.	19′ 0″	519812			
Antil. of the angle of the vertic. and declinat.	27° 3′ 29″	11591 *S.*			
Mesolog. of the vertical parall.		508221	21′ 20″	Vertical parall. at the altit.	44° 28′.

From the same observation, moreover, let us now also investigate the same parallax by the apparent and true latitudes, so that we may see how it agrees with the one found earlier from the declination. The operation is almost the same, except that here you use the angle of the vertical and the latitude. This angle we do not have at hand, nor do we care to investigate it trigonometrically just now, lest I seem excessive to you, reader. For it will be almost the same whether we take it from an artificial globe or from calculation: even if the said angle is one or two degrees larger or smaller, the parallax is still hardly changed by it, only by a very few seconds.

[Margin: Parallaxis ex declinatione.] *Parallax from the declination.*

1.

For December 23, then, at $7^h\ 22^m\ 7^s$ *vesp.*	Apparent latit.	3° 0′ 21″	*Austr.*	
	True latit.	2° 38′ 30″	*Austr.*	Since, therefore, it is smaller,
according to the preceding axiom 1, a parallax is therefore given		21′ 51″	ficti-tious	
Of this fictitious parallax	21′ 51″	Mesol. 505838		
Angle of the vertic. and latit.	12° 0′ 0″	Antil. 2209 *S.*		
		Mesol. 503629	22′ 20″	Parall. reduced to the vertical
at the altitude of the comet of about 44 deg.				

2.

For the 26th, at $6^h\ 0^m\ 0^s$, when the comet formed a straight line with the two in the foot of Perseus.

Apparent declination	31° 19′ 31″	*Bor.*		
True declination	31° 30′ 0″	*Bor.*		
Differ. of declin.	10′ 29″	Mesol. 579279		
Angle of the vertic. and declin.	40° 0′ 0″	Antil. 26651 *S.*		
		Mesol. 552628	13′ 41″	Parall. reduced to the vertical
at the altitude of the comet of about 50 deg.				

[Margin: Parallaxis pro die 26Decemb.] *Parallax for December 26.*

3.

For the 26th, at 11^{h} 44^{m} 48^{s}, the comet standing at an altitude of 51° 36′ 15″.

Apparent declination	32° 10′ 11″			
True	32° 16′ 56″			
Differ. of declinat.	6′ 45″	Mesol. 623303		
Angle of the vertic. and declin.	37° 0′ 0″	Antil. 50780 *S.*		
		Mesol. 572523	11′ 13″	Parall. reduced to the vertic.

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And so you have, for December 23 and 26, the comet's parallaxes of altitude from the declinations and latitudes, agreeing very well indeed with the parall. found above. It would certainly be pleasing if we could elicit them in the same way for the following days; but because of the excessively obtuse angle, this is in no way possible.

Parallaxes of the Comet from the apparent and true declinations.

511 the page sets these calculations unruled, labels and figures in their own columns, and each is given here as one block, its rows in the order printed. The calculation for December 23 by the latitudes and the two for December 26 are numbered 1, 2 and 3 on the page. In the first of them the sentence "since, therefore, it is smaller … fictitious" is printed at the right of the true latitude and runs on below it, ending with its figure. The marks are printed after the apparent declinations of December 23 and of the second and third calculations, after the apparent latitude, after the fictitious parallax in its two Mesol. rows, after the 21 of the first result and the altitude beside it, after the reduced parallaxes, and after the figures in the captions; the rest are supplied in the house form. The page prints no mark after the 20 of the first result. No figure is supplied, and no degree figure stands before 19 0, 21 20, 21 51, 22 20, 10 29, 13 41, 6 45 or 11 13. The tags *Bor.*, *Austr.* and *S.* and the time tag *vesp.* are the page's own.

Com-putation	At what time the observations were made: Day, Month	Hour, Min., Sec.	Altitude of the comet (Deg., Min., Sec.)	Northern declinations of the comet (Deg., Min., Sec.)	Fictitious parallax (Min., Sec.)	Vertical parallax (Min., Sec.)	Horizontal parallax (Min., Sec.)
1.	December 23	$7^h\ 22^m$ *v.*	$44^\circ\ 28'\ 0''$	$17^\circ\ 2'\ 26''$ apparent $17^\circ\ 21'\ 26''$ true	$19'\ 0''$	$21'\ 20''$	$29'\ 54''$
2.	December 26	$6^h\ 0^m$ *v.*	$50^\circ\ 0'$ *circ.*	$31^\circ\ 19'\ 31''$ apparent $31^\circ\ 30'\ 0''$ true	$10'\ 29''$	$13'\ 41''$	$17'\ 52''$
3.	December 26	$11^h\ 44^m$ *v.*	$36'\ 15''$	$32^\circ\ 10'\ 11''$ apparent $32^\circ\ 16'\ 56''$ true	$6'\ 45''$	$11'\ 13''$	$18'\ 3''$

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It now remains for us to examine the parallaxes also by the problem of the most ingenious Regiomontanus: a problem otherwise very well known to astronomers, celebrated by many, and also frequently applied to comets, for instance by Thaddaeus Haggetius [Tadeáš Hájek], Claramontius and others. To tell the truth, this is an invention that falls short in ease and certainty more than in subtlety and ingenuity. For this reason Tycho Brahe, Kepler and Crüger, men highly versed in this arena, also rejected the method outright, holding firmly that, even if that invention has acumen enough, it is nevertheless frustrated by the practice of calculation. Tycho discusses this matter splendidly and rightly in Book II on the Comet of the year 1577, p. 145: *Regiomontanus, in his second problem, where he makes each parallax in the circle of altitude known by two altitudes taken before or after the meridian in different azimuths, the time elapsed between those same two observations also being known, offers a subtle and quite ingenious speculation indeed, but one that in those smaller parallaxes, such as occur in the aether, deserves no place at all. For it builds the greatest things out of the smallest, so that an error of one or two minutes in the time, which can easily creep in, grows into an excessive deviation; and further, unless the azimuths and altitudes are obtained so scrupulously that nothing is wanting, you will have lost (as the saying goes) your oil and your labour. For a slip of a few scarcely perceptible minutes in the time and the other data easily brings about a departure of several degrees from the target of truth.* So he.

[512]a ruled, boxed table of eight columns under a caption. The head "Quo tempore fuerint observationes habitae" runs across the day column and the time column; the unit rows (Day, Month; H., M., Sec.; Deg., M., Sec.; M., Sec.) are the page's own, set in the house form in the cells. Each calculation takes two printed lines in the declination column, the apparent declination above and the true below, with the number, date, time, altitude and the three parallaxes standing between them; they are given here as two rows, with those cells in the first. The time tag *v.* and the tag *circ.* after the altitude of the second row are the page's own; that altitude carries no seconds figure. A round dot stands above the 0 of the first altitude. No figure is supplied.

[Margin: Regiomontani modus Parallaxes detegendi.] *Regiomontanus's method of detecting parallaxes.*

[Margin: Tychonis ſententia de methodo Regiomontani.] *Tycho's opinion of Regiomontanus's method.*

Nothing is truer than these words. For this method rests on the truest time between the two observations, noted most accurately, and also on altitudes and azimuths perfect in every respect (as will be said more fully shortly); and yet, for many weighty reasons, these can hardly ever be had as precisely as this business requires. It is therefore very easy to go wrong in this way. Indeed, if you have erred by only some seconds in those data, let alone by a whole first minute, you will, believe me, very easily depart from the truth by a whole degree: as could be shown more fully, if I had a mind to dwell somewhat longer on these matters and to spend a little more time on them. Nevertheless, so as not to leave this matter wholly untouched, note what the most celebrated Tycho says further on this matter in Book I on the New Star, p. 517: *If we make the second altitude* (namely that of Hájek's observation) *lower by even a single minute* (he says), *the new star* (of the year 1572) *will not only not deserve to hold a place in the highest aether, but will be pressed down somewhat below the Moon besides.*

[Margin: Autoris hâc de re ſententia.] *The author's opinion on this matter.*

[Margin: Regiomontani modus admodùm lubricus.] *Regiomontanus's method is very slippery.*

Tycho passes almost the same judgement, in Book II, p. 429, on Andreas Nolthius, otherwise an outstanding mathematician, who had elicited a parallax of 5 degrees and more for the comet (of the year 1577): *If even three first minutes, with a quarter, were lacking in the time presupposed by Nolthius, it would follow from the same altitudes and azimuths that the comet had been devoid of all parallax.* P. Crüger, once my teacher, who is always to be held in the best of memory, also fully subscribes to this opinion, in his *Uranodromus Cometicus*, p. 91. For he says: *if on p.* 44 (of the *Uranodromus*) *the time of the later observation had exceeded by only two seconds, I would have found no parallax at all. But now, since it falls short by so many seconds, the parallax grows to almost half a degree.*

[Margin: Cui ſententiæ etiam Crügerus ſubſcribit.] *Crüger also subscribes to this opinion.*

I have myself experienced this more than enough. For even if you go astray by only a very few seconds, whether in the altitude, or the azimuth, or the time, derived either from clocks or from the altitudes of the fixed stars, nevertheless, if you have worked according to Regiomontanus, no slight error can intrude, one that sets up a parallax of a whole degree where in fact there is none. Not to mention, finally, that if you neglect one or two seconds in the calculation itself, you will sometimes suffer a loss of up to half a degree. Indeed, even if you have observed both the seconds and the thirds as diligently as possible, you will still elicit nothing at all accurate from this method. The reason is that this problem abounds in excessively enormous triangles: at one time the sides of the triangles are 30, 40, 50, 60 or 70 degrees, while the angles amount to only

1, 2 or 3 seconds; at another the sides given are very small, and the angles in turn very obtuse, so that, as geometry teaches, nothing at all certain can be hoped for from it. For any error, however slight at first, mixes itself more and more with one absurd triangle after another, and grows more fruitful as the operation proceeds, so that in the end it produces a very notable error. Add, if you like, that you solve all the triangles in Regiomontanus's calculation by some definite geometrical method, from certain givens, as exactly as possible; yet if you assume other data again (angles, namely, in place of sides, or vice versa sides in place of angles) and use another way of solving the triangles, almost never does one and the same result come out. Hence, with one definite method of calculation correctly begun, the parallax runs at one time to about half a degree, and with another method of calculation, equally definite, at another time to scarcely a very few minutes, even though everything has been computed with equal diligence. We shall give a clear example of this in the second calculation that follows: in it the parallax came out at 25 minutes by Crüger's way, whereas, when my method is kept, although it rests on equally solid foundations, it is only 10′.

[Margin: Neglecto uno alterove ſecundo in calculo Regiomontani, ad ſemigradum aberrabis.] *If one or two seconds are neglected in Regiomontanus's calculation, you will go astray by up to half a degree.*

[Margin: Quare iſta methodo nihil certi acquiratur.] *Why nothing certain may be obtained by this method.*

[Margin: Evidens demõſtratio quod calculo Regiomontani nullâ ratione innitendum ſit.] *A clear demonstration that Regiomontanus's calculation is in no way to be relied on.*

Therefore, in whatever way you approach Regiomontanus's calculation, you will nonetheless always have something you may rightly doubt; nor will you ever be able to be sufficiently certain whether the parallax amounts to a few minutes or to a few degrees. The most sagacious Kepler strongly supports me in this, in the *Hyperaspistes*, p. 73, against Claramontius, when he says: *And so not only in the smallest parallaxes, as Tycho said, does this demonstration have no place, but not even in large ones, which Tycho was prepared to concede to Regiomontanus, is any security to be hoped for. In short, so great an agreement of the time interval with*

[Margin: Nunquam in calculo Regiomontani acquieſcere potes.] *You can never rest content with Regiomontanus's calculation.*

[Margin: Aſſentit Kepplerus.] *Kepler agrees.*

the azimuths cannot be hoped for from the observer's diligence that both can be mixed together at once in the same demonstration, and the one inferred from the other by reasoning, as the method of the demonstration requires, and compared with the nearest observations in order to establish the angles L Z N, L N Z. For the whole matter turns on the proportion of these triangles.

Since, therefore, this method of Regiomontanus is so doubtful and ambiguous that nothing whatever of the truth can be elicited by its help, it is rightly

asked here why, then, I have proposed to investigate the parallaxes by this method. I answer: although I am entirely of the opinion that nothing at all accurate and solid is extracted in that way, let alone that parallaxes more certain than ours, found by the distances, can be given by it, nevertheless, lest anyone persuade himself that I have understood the analysis of this calculation not in the least correctly, or have avoided this calculation on purpose, I wished to examine the parallaxes by means of this one too. In this way it may at the same time be clear to everyone that the parallaxes to be found by this method also differ little or not at all from those found above, so that we may thus be the more secure that the parallaxes have been deduced most exactly, since almost all of them, each and every one, agree in every respect, by whatever route they have been investigated. But if this problem produced quite peculiar parallaxes, far different from the earlier ones, whether large, or very small, or even none at all, while all the other investigations, that is, clearly maintained the contrary, I would attribute nothing whatever to it.

[Margin: Cur Autor nihilominus hâc viâ parallaxes iverit quæſitum.] *Why the author nevertheless went to seek the parallaxes by this route.*

[Margin: Etiam parallaxes Regiomontani methodo erutæ noſtris optimè reſpondent.] *Parallaxes extracted by Regiomontanus's method also agree very well with ours.*

Indeed, Regiomontanus's calculation not rarely shows no parallax at all, when in fact there is some; at times it shows a parallax of only a very few seconds, when in fact the parallax amounts to many minutes; at times, too, the contrary happens, as will be made very plain from the first example below, to be set up for December 27. For there, at an altitude of the phenomenon of 52° 24′, the parallax of altitude is given as only 33″ and the horizontal as only 54″; whereas countless other investigations, worked out in very different ways and with the greatest diligence, for the same day, the 27th, and the same altitude, all show that the parallax was 11′, 12′, or even 14′. Again, from the second calculation the parallax is found to be 25′, although all the other inquiries consistently indicate a parallax of scarcely 5 or 6 minutes.

[Margin: Abſurditates calculi Regiomontani.] *Absurdities of Regiomontanus's calculation.*

But so that you may see that the matter stands entirely as we have just said, I wished, and not grudgingly, to investigate the parallaxes by four different calculations, and indeed by means of logarithms, which, so far as I know, has not been undertaken before now. We shall therefore append the whole calculation: partly so that beginners may better grasp the entire process of this computation, which, by reason of the very many triangles to be solved, is otherwise very intricate and lengthy; partly so that the more skilled may more easily examine each member of this calculation, and see without any labour that everything has been deduced duly and rightly.

First, therefore, it will be necessary for us to explain in order and clearly, with the help of two diagrams, the whole analysis of the calculation to be set

up. On this occasion I want you to know at the same time that Regiomontanus founded this problem on two altitudes and azimuths observed at a fixed time, and presupposed that the comet was entirely free of proper motion. But since our comet continually exercised a notable proper motion, this problem not so barely, as indeed

[Margin: Quâ cautelâ hîc calculus incipiendus eſt.] *With what caution the calculation is to be begun here.*

proposed by the author, is to be begun; rather, it first needs a limitation, namely of the distance from the meridian, and then of the altitude and azimuth of the second observation. How this should be done, and above all by what method the proper motion may be wholly removed and the azimuths reduced, so that the comet stands as if motionless and endowed with no motion other than that of the primum mobile, Tycho Brahe has explained very suitably; and we shall follow him on this occasion too.

In the first of the diagrams set here, let H A N be the meridian, H N the horizon, K M the equator, A the vertical point, B the pole, the circles A G and A F circles of altitude, B I and B E circles of declination, and P C D O the orbit of the comet, so that the comet, by its proper motion between the earlier and the later observation, has advanced from C to D. Since, then, our comet, tending upward, made the later altitude in the second observation greater by its proper motion (namely because its declination was increasing) than if it had been wholly free of all proper motion and its declination had always remained the same in both observations, it will therefore have to be investigated at the outset how great, namely, or how much smaller, both the altitude and the azimuth of the comet in the later observation would be, the comet being supposed entirely free of all proper motion. When these have been found, we first take up that problem of Regiomontanus.

[Margin: Proceſſus calculi Regiomontani.] *The procedure of Regiomontanus's calculation.*

Diagram. An engraved block standing across the text measure between the two paragraphs, printed upside down, so that every label stands inverted to the text; it is described here turned upright. Two circles stand side by side, each a sphere projected in a circle with its horizon, arcs and dotted construction lines, and the comet's points marked; no caption is printed. The words are engraved script, the point letters roman capitals.

Left circle in the upright view (the right-hand circle as the page stands): the outer circle; a curve across the middle from N at the left rim to H at the right rim, labelled "Horizon." above it at the left; a straight line from L at the lower left rim rising through the horizon to K at the upper right rim, with the word for the equator written along it at the lower left; arcs from B to I and to E on that line; arcs from A down to G and F on the horizon; a dotted line from O down through D and C to P beside E; a dotted line from A down to M; "Oriens." in the lower half.

- O (top of the rim, left of A)

- A (top of the rim)
- B (upper left rim)
- M (inside, foot of the dotted line from A)
- D (inside, on the dotted line)
- K (upper right rim, end of the straight line)
- C (inside, on the dotted line)
- I (on the straight line, right)
- P (beside E, end of the dotted line)
- E (on the straight line, beside P)
- N (left rim, end of the horizon)
- Horizon. (above the horizon, left): "Horizon"
- H (right rim, end of the horizon)
- G (foot of an arc on the horizon)
- F (foot of an arc on the horizon)
- the word along the straight line, lower left: "equator", its script initial not separated between A and Æ [?]
- L (lower left rim, end of the straight line)
- Oriens. (lower half): "East"

Right circle in the upright view (the left-hand circle as the page stands): the outer circle; a curve across the middle from C at the left rim to B at the right rim, labelled "Horizon." above it at the left; two parallel straight lines rising from D and from S on the lower left rim toward the upper right, carrying the two labels on the semid. arcs; H on the upper left rim and Z at the top of the rim, with arcs drawn from each; dotted lines from H and from Z to V outside the rim, and a dotted line from V down to T; L, I, M, X, N, Y, G and O at intersections inside; P and R at the feet of arcs on the horizon, and E and K below the horizon; "Oriens." in the lower half; below the circle at its right, the engraver's line.

- V (outside the rim, at the top)
- Z (top of the rim; a Z with a crossbar)
- H (upper left rim)
- T (inside, end of the dotted line from V)
- A (upper right rim)
- L (inside, upper right)
- E (right rim)
- I (inside, beside L)
- M (inside, beside I)
- X (inside, left of I)
- Y (inside, right of N)
- G (inside, on the upper straight line)
- N (inside, below I)
- Horizon. (above the horizon, left): "Horizon"
- Arcus ſemid. Com. verus (along the upper straight line): "the comet's true semid. arc", the abbreviation semid. left unexpanded

- O (inside, on the horizon's upper side)
- C (left rim, end of the horizon)
- B (right rim, end of the horizon)
- P (foot of an arc on the horizon)
- R (foot of an arc on the horizon)
- Arcus ſemid. Com. viſus. (along the lower straight line): "the comet's apparent semid. arc"
- E (below the horizon, beside K)
- K (below the horizon, foot of the arc from O)
- D (lower left rim, end of the upper straight line)
- S (lower left rim, end of the lower straight line)
- Oriens. (lower half): "East"
- Autor ſculpſit. (below the circle, right): "The author engraved it."

All printed labels are listed; none was left unread. Which straight line ends at A and which at E on the right rim of the right circle was not traced.

Thus: 1. Let the angle A B C of the later observation be sought; it becomes known from the sum (in this our first example) of the comet's ascensional difference in each observation and of the distance from the meridian.

2. In the triangle A B C, given the angle A B C that has been found, and A B, the complement of the elevation of the pole, let the perpendicular A M be explored. Likewise B M, from A B and the perpendicular A M.
3. When B M is subtracted from the complement of the declination of the earlier observation, M C will remain.
4. From M C and A M let A C be investigated; its complement to 90° is the limited altitude of the comet in the second observation, as if it had lacked proper motion.

With this corrected altitude found in this way, let the corrected azimuth of the second observation also be computed.

1. In the triangle B A M, from A B, the complement of the elevation of the pole, and M B, found above, let the angle M A B be sought.
2. In the triangle C A M, from A C, the complement of the limited altitude, and C M, likewise found above, let the angle C A M be investigated.[513]
3. Let the sum C A B of these two angles be subtracted from the semicircle, and you will have the angle H A F, or H F, the limited azimuth of the second observation, as if it had had no proper motion.

With the altitude and azimuth of the later observation thus corrected, let us elucidate Regiomontanus's diagram itself, so that we may proceed more successfully with the task we have undertaken.

[Margin: Dilucidatio Schematis Regiomontani.] *Elucidation of Regiomontanus's diagram.*

In the second of the two figures attached, let B S be the horizon, B Z S the meridian, Z the pole of the horizon, H the pole of the equator, A L G D the

[513] in steps 1 and 2 the two givens of each triangle are printed one above the other between tall square brackets, with "ex" before them and the instruction for the angle sought after them.

true semidiurnal arc, and Q O S the apparent one. O is the apparent place of the comet in the earlier observation, G its true place; M is the apparent place of the comet in the later observation, L its true place; and O K is the apparent altitude of the earlier observation, G K the true one. Likewise R M is the apparent altitude of the earlier observation, R L the true one; L G is the true arc of time [arcus temporarius] between the two observations. To its endpoints L and G let the circles of declination H L and H G be drawn; let L H N be made equal to the angle G H O, and through N let a third vertical circle, Z N P, be drawn.

Since, then, the comet entirely lacks proper motion (as indeed it has actually been stripped of all proper motion by the preceding calculation), it therefore advances from the true place G to the true place L; and with the same quantity of motion it also advances from the apparent place O, along the apparent semidiurnal arc, to the point N. Once L N is drawn, therefore, it is equal to G O, just as N H is equal to O H, and the angle L H N to the angle G H O; hence the triangles L H N and G H O are entirely equal to each other, so that, for the calculation, the one may rightly be used in place of the other. From this it is proved that G O, or L N, is the parallax of the earlier observation, and L M the parallax of the later observation; these are what must be investigated on this occasion.

1. In the triangle Z H O, with the perpendicular H V let fall, let the perpendicular H V be sought from Z H, the complement of the elevation of the pole, and V Z H, the complement of the azimuth of the earlier observation. Then in the right-angled triangle H V O, from the perpendicular H V and H O, the complement of the declination of the earlier observation, let V O H, or Z O H, or G O H be explored. Or, what is the same thing, let a perpendicular be let fall from Z onto the line O H; then from the angle O H Z, the distance from the meridian of the earlier observation, and H Z, the complement of the elevation of the pole, let the perpendicular be sought; finally, from this perpendicular and O Z, the complement of the earlier altitude, the angle Z O H is found.

[Margin: Methodus Calculi.] *Method of the calculation.*

2. Since the angles G H O and L H N are entirely equal to each other, if you add the common angle N H G to each, the angle L H G will also be equal to the angle N H O, because the arcs L G and N O, described from the same pole, are similar to each other. Therefore, when G L or O N, or the angle L H G, the interval of time converted into degrees and minutes, is subtracted from the angle Z H O, namely the distance from the meridian of the earlier observation, the angle Z H N will remain: the distance from the meridian in the later observation.
3. In the triangle Z H N, with the perpendicular Z T let fall, the perpendicular Z T is found from the side Z N, namely the complement of the elevation of the pole, and the angle Z H N just found. From this perpendicular Z T and Z H, let the side H T be computed; it is to be subtracted from the complement of the declination of the earlier observation, so that

N T remains. Then, by means of this N T and the perpendicular Z T, let the required Z N be investigated. If it is greater than Z M, namely the complement of the limited altitude (which in the preceding figure of Tycho's limitation was called A C), some parallax lies hidden in these observations; but if Z N is equal to Z M, or somewhat smaller, there is no parallax present at all, and so the calculation ends here; but if it is greater, it is to be continued.

[Margin: Ex quibus cognoſcatur parallaxin ſubeſſe.] *From which it may be recognized that a parallax is present.*

4. In the right-angled triangle Z T H, from the hypotenuse Z H, the complement of the elevation of the pole, and H T, found in step 3, let the angle T Z H be explored; then in the triangle Z T N, from N Z, found above, and N T, let the angle N Z T be sought. Let the sum of this angle and the angle T Z H be subtracted from the semicircle, and you will have the angle B Z P; when it is taken from B Z R, the corrected and limited azimuth of the second observation, the angle R Z P, or L Z N, will result.
5. In the orthogonal triangle Z T N, the angle Z N T, or Z N H, is found from N Z and T Z.
6. In the oblique-angled triangle M Z N, let the perpendicular M X be sought from Z M, the complement of the apparent limited altitude of the second observation, and the angle R S P, found in step 4; again, from this perpendicular M X, now found, and Z M, the side Z X; let it be subtracted from Z N, found in step 3, and the remainder is X N. Afterwards, from X N and M X, M N will result.
7. In the right-angled triangle Z M X, from Z M and Z X let the angle Z M N be computed; likewise, in the smaller triangle M X N, also right-angled, from M N and N X, the angle N M X. The sum of these two angles, once found, gives the angle Z M N, or L M N.
8. In that smaller triangle M X N, let the angle M N X, or M N Z, also be investigated from M N and M X.
9. To this angle M N Z that has been found, let Z N H, obtained in step 5, be added, and you will have the angle M N H; when the angle L N H, found in step 1, is taken from it, the angle M N L, or M N I, will remain.
10. Finally, in that small oblique-angled parallactic triangle M N L: since L N is equal to G O, once this side is known, the parallax of the earlier observation itself becomes known; and once L M has been found, the parallax of the later observation itself. Before one arrives there, however, let the perpendicular M I be let fall from the obtuse angle N M L; it is to be sought from M N, found in step 6, and the angle M N L, or M N I, obtained in step 9.

[Margin: Prodit Parallaxis.] *The parallax emerges.*

11. In the right triangle M I N, let N I be computed from M N and the perpendicular M I.

12. In the same triangle, from M N and N I, the angle N M I is found; subtracted from the obtuse angle N M L, obtained in step 7, it leaves the angle I M L.
13. Finally, in the triangle M I L, from the side M I and the angle I M L just found, I L becomes known; when N I (step 11) is added to it, L N will result: the parallax of the earlier observation, namely of the smaller altitude.
14. Lastly, from the perpendicular M I (step 10) and I L (obtained in the preceding step), L M is found: the parallax of the later observation, namely of the greater altitude.

This, then, is Regiomontanus's method of calculation. It is not only quite lengthy, tedious and intricate, but also depends on resolving many triangles, and ill-formed ones at that, so that hardly anything certain can be drawn from it at any time or from any observations whatever. Moreover, if we examine the matter more deeply, the source of error lies hidden not only in the first steps of the calculation (namely, that the bare altitude and azimuth mostly differ from the limited ones by only a very few seconds, so that the angle L Z N mostly amounts to only a few seconds); above all, some doubt also arises in the later part of the calculation. From such very small sides as M N and N X, namely, an angle can in no way be explored accurately: for instance, in step 7, the angle N M X; in step 8, the angle M N Z or M N X; likewise in step 12, the angles M N I and I M L, and so on. For if you depart in the sides by even one or two seconds only (as can easily happen), you will certainly be mistaken in the angles by several degrees. Therefore, if the angle M N I is changed by only one degree, or at most two, then instead of a parallax of a few minutes you will surely have another of several degrees. So much so that, as we have often impressed before, there is no certainty at all in this calculation, since those monstrous triangles in the earlier part of the calculation cannot by any means be eliminated. In the later steps of the calculation the task is indeed helped to some extent if you assume entirely different triangles and more suitable givens; but this does not satisfy completely. Meanwhile, however, I shall briefly set out here this method of carrying out the calculation as well, which I have devised: both so that the investigation itself, from step 4 to 13, may become somewhat easier and the triangles may be constructed far more expeditiously, and above all so that the angle I M L, which is obtuse and mostly fills out a right angle, may be avoided entirely.

[Margin: Regiomontani calculus benè prolixus & tædioſus eſt.] *Regiomontanus's calculation is quite lengthy and tedious.*

[Margin: Quo in calculi membro error potiſſimus lateat.] *In which step of the calculation the chief error lies hidden.*

[Margin: Monſtroſa triangula hâc ſervatâ methodo neutiquam evitari poſſunt.] *While this method is kept, the monstrous triangles can by no means be avoided.*

[Margin: Quâ ratione ex parte huic calculo ſubveniri poſſit ?] *By what means this calculation can be partly helped?*

First: once step 8 is done, let the perpendicular N Y be let fall from the point N onto the vertical circle Z R; it is to be sought from Z N (obtained in step 3) and the angle N Z L (known from step 4). Then, in the same triangle Z Y N, let the angle Y N Z be explored from the perpendicular Y N and the earlier angle N Z L; likewise the side Y Z, given the two sides N Z and Y N.

Second: from the angle M N Z, obtained in step 8, subtract the angle M N L; the remainder gives the angle L N Z. Let this in turn be subtracted from the angle Y N Z, found in the preceding step, and you will have the angle Y N L.

Third: in the triangle Y N L, from the side Y N and the angle just explored, let the side Y L be sought; it is to be subtracted from Y Z (computed in step 1), and Z M will remain. Let this in turn be taken from M Z, that is, from the limited altitude found at the outset, and thus L M, the parallax of the later observation, will result.

Fourth and last: in the triangle L Y N, from the two sides L Y and Y N, let the hypotenuse L N be sought: the parallax of the earlier observation.

Just as I much prefer this method of calculation to the other, so for the most part it also agrees better with those parallaxes investigated through distances. And yet this aid does not make the whole calculation of Regiomontanus, as we have indicated, altogether more complete and more certain, so that we could rely on it alone. But insofar as it corresponds very closely with the other investigations of parallaxes carried out through distances, to that extent it is to be tolerated; but if the calculation of Regiomontanus alone indicates the contrary, it is to be rejected entirely.

[Margin: Quâ ratione calculus Regiomontani tollerandus ſit ?] *In what way Regiomontanus's calculation is to be tolerated?*

Since, therefore, we have already examined the parallaxes by safer and various routes, now these too by this route of Regiomontanus, and indeed, in this first example, according to the former method, from two altitudes and azimuths observed on the evening of 27 Dec.

[Margin: Diverſitas adſpectus exploratur juxta Regiomontanum.] *The parallax is explored according to Regiomontanus.*

Investigation of Parallax I, according to Regiomontanus. For 27 December. [Inveſtigatio Parallax. I. juxta Regiomontanum Ad diem 27 Decembr.]

1 Obs. at	$5^h\ 33^m\ 39^s$	Altit. of the com.	52° 40′	azimuth	77° 0′	*Orient. Mer.*	Declin.	34° 20′ 24″
2 Obs. at	$5^h\ 40^m\ 48^s$	Altit. of the com.	53° 30′	azimuth	75° 14′	*Orient. M.*	Declin.	34° 25′ 11″

1 Obs. right asc. of the comet	46° 48′ 53″	Right asc. of the Sun at the later obs.	277° 21′ 12″		
2 Obs. right asc. of the comet	46° 39′ 42″	Elongat. from the merid.	85° 12′ 0″	*Add.*	
Ascensional difference	9′ 11″	Right asc. of the midheaven	2° 33′ 12″	360 degrees cast off	
		Right asc. of the com. at the 2nd observ.	46° 39′ 42″		
		Dist. from the merid.	44° 6′ 30″		
		Differ. of ascens. here	9′ 11″	*Add.* in the quad., namely *Or. Mer.*	

A B	35° 37′ 8″	Log. 54061		Angle A B C		44° 15′ 41″
Ang. A B C		Log. 35964 *A.*	° ′ ″	Antil. 20713		
Perpend. A M		Log. 90025	23° 58′ 39″	Antil. 9029 *S.*		
Antil. M C	12916			B M	Antil. 11684	27° 9′ 58″ *Subt.* here.
Antil. A M	9029 *A.*		° ′ ″	Compl. of the declin. at the earlier obs.		55° 39′ 36″
Antil. A C	21945		36° 35′ 11″	its compl. is	Side M C	28° 29′ 46″
Altitud. of the com. in the 2nd obs.			53° 24′ 49″	limited, as if it had lacked proper motion; by which it is 5′ 11″ smaller than the apparent altitud. of the observ.		

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1	In triang. B A M from	A B	Log. 54061 *S.*		
		M B	Log. 78411		
	Angle M A B		Log. 24350	51° 37′ 3″	
2	In triang. C A M from	A C	Log. 51745 *S.*		

[514] set unruled, in the page's own columns, with short rules under several figures. The marks are printed after the first time, the altitude, azimuth and declination of the first observation, both right ascensions of the first group, A B, and the 5 11 of the last line; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The tags *A.*, *S.*, *Add.*, *Subt.*, the direction tags *Orient. Mer.*, *Orient. M.* and *Or. Mer.*, and the point-letters are the page's own.

	C M	Log. 74003	
Angle C A M		Log. 22258	53° 10′ 20″
			104° 47′ 23″
Compl. to 180°. It is the azimuth of the sec. observ.			75° 12′ 37″ as if it had lacked proper motion.

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[Margin: Az:muth ſecundæ obſervationis.] *Azimuth of the second observation.*

Corrected altitudes and azim., therefore [Correctæ igitur altitudines & Azim.]

1 Obs. at	$5^h\ 33^m\ 39^s$	Altit.	52° 24′ 0″	Azim.	77° 0′ 0″	*Orient. M.*	K Z B or O Z Q.
2 Obs. at	$5^h\ 40^m\ 48^s$	Altit.	53° 24′ 49″	Azim.	75° 12′ 37″	*Orient. M.*	
Differ.	$7^m\ 9^s$						

	H O	Compl. of the apparent declin., 1 Observ.
In triang. Z H O all the sides are given	Z O	Compl. of the apparent altit., 1 Observ.
	Z H	Compl. of the elevat. of the pole

Likewise the angles	O Z Q	or the compl. V Z H, azimuth of the 1st observ.	The angle sought	H O Z	Distance from the mer.
	Z H O	Distance from the merid. of the 1st observ.		Z H O	

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Right asc. of the Sun, 1st observ.	277° 20′ 52″	
Elong. from the merid.	83° 24′ 45″	*A.*
Right asc. of the midheaven	0° 45′ 37″	360 degrees cast off
Right asc. of the com., 1st obs.	46° 48′ 53″	

[515] in each of the two worked steps the step figure and "In triang. … ex" stand centred between the two sides, which are printed one above the other with their logarithms.

[516] the three sides H O, Z O, Z H are gathered by a tall square bracket opening to the right; in the second group "O Z Q" and "Z H O" stand between square brackets, "Quæritur ang." and "Diſtantia à Mer." are centred between the two lines, and "H O Z" over "Z H O" is closed by a square bracket.

Dist. from the merid.			46° 3′ 16″	Z H O.	

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1	Log. Z H, compl. of the elev. of the pole	54061			
	Log. of the ang. V Z H, compl. of the azim.	2596 *A.*	Observ. 1.	77° 0′	
	Log. of the perp. H V	56657	34° 34′ 26″	Log. 56657	
			Hyp., compl. of the declin., 1st observ.	Log. 19153 *S.*	
	Angle Z O H or G O H			Log. 37504	43° 24′ 50″, and the angle L N H is also just as great.

2	Interval of time 7^m 9^s, converted into degr., G L or O N or L H G	1° 47′ 15″	*Subt.* here
	The distance from the mer. at the earlier observat. was	46° 3′ 16″	Z H O
	Angle Z H N	44° 16′ 1″	only 1′ 38″ greater than the one composed from the different. of ascens., which was 44° 15′ 39″.

3	In triangle Z H N are given	Z H, compl. of the elev. of the pole		35° 37′ 8″	
		N H, compl. of the apparent declin. at the earlier obs.		55° 39′ 36″	Z N is sought
		Z H N, the included angle			

Log. Z H	54061			Ant. 20713		
Log. Z H N	35954 *A.*	° ′ ″				
Log. of the perp. Z T	90015	23° 59′ 8″		Ant. 9031 *S.*	° ′ ″	Ant. 9031
			H T	Ant. 11682	27° 9′ 40″	

[517] set unruled, in the page's own columns, with short rules under 83 24 45 and 46 48 53. The marks are printed after the corrected first time, altitude and azimuth, 180, 51 37 3 and the Sun's right ascension 277 20 52; the rest are supplied in the house form; no figure is supplied. The 0 of 0° 45′ 37″ is printed.

	Compl. of the declin. at the earlier obs.	55° 59′ 36″		
	There remains T N	28° 29′ 56″	Ant. 12917	° ′ ″
			Z N Ant. 21948	36° 35′ 18″
			Its complement N P	53° 24′ 42″

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[Margin: Vnde conſtet parallaxin obſervationibus ſubeſſe.] *From which it may be established that a parallax is present in the observations.*

Since, therefore, Z N is 7″ greater than the complement (namely, of the limited altitude) Z M, it follows that some parallax is present in the observations, and the calculation must be continued. But if they had been equal, or Z N somewhat smaller, then no parallax at all could have been expected.

4	In the same triang. N Z H	Log. of the hyp. Z H		54061 *S.*	
		Log. H T	27° 9′ 40″	78420	° ′ ″
		Log. T Z H		24359	51° 36′ 37″
		Log. N Z	36° 35′ 18″	51740 *S.*	
		Log. N T	28° 29′ 56″	73994	
		Log. N Z T		22254	53° 10′ 30″
					104° 47′ 7″
		Compl. to 180 degr.			75° 11′ 53″ is the angl. B Z P.
		Azimuth of the sec. observ., corr. and limit.			75° 12′ 37″
		Angle R Z P or L Z N			44″

5	In the same triangle Z N H let the angl. Z N H be sought.			
	Log. of the hyp. N Z	36° 35′ 18″	51740 *S.*	

[518] set unruled, in the page's own columns, with short rules under several figures. The marks are printed after 77 0, 34 34 26, 43 24 50, the time 7 9 (as ′ and ″), 1 47 15, 1 38, 44 15 39, 35 37 8 and 55 39 36; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. In step 3 the given sides are gathered between tall square brackets, "3 In triangulo Z H N dantur" at the left and "quæritur Z N" at the right. The tags *A.*, *S.*, *Subt.* and the point-letters are the page's own. The complement of the declination stands 55° 39′ 36″ in step 3 and 55° 59′ 36″ four lines below, as printed.

	Log. of the perp. T Z				23° 59′ 8″	90015	
	Log. of the angl. Z N T					38265	or Z N H 43° 0′ 16″

		Z M, compl. of the apparent altit. at the 2nd obs., limit.					
6	In triang. N Z M from	N Z				36° 35′ 18″	Side M N is sought
		R Z P, the angle just found				44″	

Log. Z M		36° 35′ 11″	51746		Antil. 21945.152			
Log. of the ang. R Z P		44″	845273 *A.*	′ ″				
Log. of the perp. M X			897019	0′ 26½″	Antil. 0.079 *S.*		M X	Ant. 0.00079
				Z X	Antil. 21945.073	36° 35′ 11″		
				Side Z N was		36° 35′ 18″		
				Therefore X N		7″		Ant. 0.00006
				M N		0′ 27″		Ant. 0.00085

7	In the same triangle, from all the sides now given, the angle Z M N is sought.				
	Log. Z M	36° 35′ 11″	compl. of the appar. lim. altit.	51746	
	Log. Z X	36° 35′ 18″	found in part 6	51746	
	Log. of the ang. Z M X			0	90° 0′ 0″
	Log. M N	0′ 27″	found in part 6	894108 *S.*	
	Log. N X	0′ 7″	part 6	1029101	
	Log. of the ang. N M X			134993	15° 1′ 34″
	Angl. Z M N or L M N				105° 1′ 34″

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8	For the angle M N Z in the same triangle.							
	Log. M N		0′ 27″	894108 *S.*				
	Log. M X		0′ 26½″	897019	° ′ ″			
	Log. of the ang. M N X or M N Z			2911	76° 14′ 34″			
9	Add the angl. Z N H, part 5.				43° 0′ 16″			
	Angle M N H				119° 14′ 50″	from which subtr. L N H, found in the part.		
	L N H				43° 24′ 50″			
	There remains the angle M N L or M N I				75° 50′ 0″			

10	Log. M N	0′ 27″	894108	11. Ant. 0.00085			12. Log. 894108 *S.*		
	Log. of the ang. M N L		3088 *A.*						
	Log. of the perp. M I		897196	0′ 26″	Ant. 0.00079 *S.*				
				N I	Ant. 0.00006	0′ 7″	Log. 1029101	° ′ ″	
						Angle N M I	Log. 134993	15° 1′ 34″	
				13.	Angl. N M L, found in part 7.			105° 1′ 34″	
						There remains the angl. I M L		90° 0′ 0″	

14	Side or perp. M I	0° 0′ 26″	Log. 897196 +		
	Of the angle I M L	90° 0′ 0″	Mesol. 0 +		*Ad.*, that is, *S.*
	Side I L		Mesol. 897196 +		0′ 26″

[519] set unruled, in the page's own columns, with short rules under several figures. The marks are printed after 27 9 40 and 36 35 18 in step 4, 36 35 18 and 43 0 16 in step 5, 36 35 18 and 44 in the bracket of step 6, 36 35 11 at its three places, and 90 0 0; where the marks stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The 0 of 0′ 26½″, 0′ 27″ and 0′ 7″ is printed. In step 6 the three givens are gathered between tall square brackets, "6 In triang. N Z M ex" at the left and "quæritur Latus M N" at the right. The tags *A.* and *S.* and the point-letters are the page's own. As printed: 180 less 104° 47′ 7″ is set as 75° 11′ 53″, and the logarithm of the angle Z N T as 38265.

		To which add N I	0′ 7″
		Parallax of the earlier observ., L N	0′ 33″
Antil. of the side M I	0′ 26″	0.0008	
Antil. of the side I L	1′ 49″	0.0139 *Add.*	
Antil. of the hyp. M L, parall. of the later obs.		0.0147	0′ 52″

520

[Margin: Ex hâc inveſtigatione parallaxis nimis exilis prodit.] *From this investigation the parallax comes out far too slight.*

Thus, by this method of Regiomontanus that we have taken up, the parallax for 27 December at 5^h in the evening, at an altitude of the comet of about 53°, comes out as only 33″ or 52″; and consequently the horizontal parallax as 55″, or at most 1′ 26″. Above, however, from the distances and altitudes, that same parallax came out larger: 10, indeed 12, minutes. But so that the matter may become more certain, let us explore, by yet another inquiry for this same 27 December but from two different observations, whether such a slight parallax springs out again. We will set up the calculation first by the usual method, and then also by that other method which we gave above.

Investigation of Parallax II, for 27 December [Inveſtigatio Parall. II. ad diem 27 Decembr.]

1 Obs. at	$5^h\ 23^m\ 58^s$	Altit. of the com.	51° 16′	Azim. 78° 55′	*Or. M.*	Declin. of the com.	34° 33′ 14″
2 Obs. at	$5^h\ 50^m\ 9^s$ $26^m\ 11^s$	Altit. of the com.	55° 6′	Azim. 72° 19′	*Or. M.*	Declin. of the com.	34° 27′ 56″

1 Obs. right asc. of the com.	46° 24′ 41″	Right asc. of the Sun at the later obs.	277° 21′ 39″
2 Obs. right asc. of the com.	46° 17′ 14″	Elong. from the merid.	87° 32′ 15″

520 set unruled, in the page's own columns, with short rules under several figures. The marks are printed after 0 27 (twice), 0 26 (three times), 0 7 and 0 52, and over 0 0 26 in step 14; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The 0 of 0° 0′ 26″ and of the small arcs in minutes and seconds is printed; 0.00085 and the other small antilogarithms are printed as they stand. The step figures 11, 12 and 13 are set within the lines, as on the page. The signs + after the logarithm and mesologarithms in step 14 are the page's own, as are the tags *A.*, *S.*, *Add.* and *Ad.* and the point-letters.

Ascensional differ.	7′ 27″	Right asc. of the midheaven	4° 53′ 54″		
		Right asc. of the com., 2 obs.	46° 17′ 14″		
		Dist. from the merid.	41° 23′ 20″		
		Diff. of ascens. here	7′ 27″	*Add.* in the quad., namely *Or. Mer.*	
		Angle A B C	41° 30′ 47″		

Log. A B	35° 37′ 8″	54061		Ant. 20713	
Log. of the ang. A B C		41124 *A.*	° ′ ″		
Log. of the perp. A M		95188	22° 42′ 23″	Ant. 8068 *S.*	
			B M	Ant. 12645	28° 12′ 33″ *Subt.* here.
Antil. M C	11902				55° 36′ 46″ Compl. of the decl. at the earlier obs.
Antil. A M	8068 *A.*		° ′ ″		27° 24′ 13″ Side M C
Antil. A C	19970		35° 1′ 1″	A C, its compl. is	
Altitud. of the com., 2 obs. and observed altitude.			54° 58′ 59″	limited, as if it had lacked proper motion; 7′ 1″ smaller than the apparent	

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[Margin: Altitudo Cometæ limitata.] *The altitude of the comet, limited.*

1	In triang. B A M, from	A B	Log. 54061 *S.*	
		M B	Log. 74931	
	Angl. M A B		Log. 20870	54° 15′ 26″
2	In triang. C A M, from	A C	Log. 55544 *S.*	

[521] set unruled, in the page's own columns, with short rules under several figures. The marks are printed after the first time 5 23 58 (as ′ and ″), the first altitude, azimuth and declination, both right ascensions of the first observation and of the Sun, A B, and 7 1, and over 28 12 33; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The direction tags *Or. M.* and *Or. Mer.*, the tags *A.*, *S.*, *Add.*, *Subt.* and the point-letters are the page's own. As printed: the logarithm of the perpendicular A M is set as 95188, and the complement of the declination at the earlier observation as 55° 36′ 46″.

	C M	Log. 77597	
Angl. C A M		Log. 22053	53° 19′ 45″
			107° 35′ 11″
Compl. to 180°, is the azim. of the 2nd observ., lim.			72° 24′ 49″ and corr., as if it had lacked prop. motion.

The corrected altitudes and azimuths, therefore [Correctæ igitur altitud. & azim.]

[Margin: Correctæ altitudines.] *Corrected altitudes.*

1 Obs. at	$5^h\ 23^m\ 58^s$	altit.	51° 16′ 0″	azim.	78° 55′ 0″	*Orient. M.*
2 Obs. at	$5^h\ 50^m\ 9^s$	altit.	54° 59′ 0″	azim.	72° 24′ 24″	*Orient. M.*
Differ.	$26^m\ 11^s$					

	H O, compl. of the apparent declin., 1st obs.		
In triangle Z H O all the sides are given	Z O, compl. of the appar. altitud., 1st obs.		H O, the side
	Z H, compl. of the elev. of the pole.	is sought	H O Z, the angl.
	O Z H, azim. at the earlier observ.		Z H O, which mea-
Likewise the angles	Z H O, dist. from the mer., 1 observ.		sures the dist. from the mer. at the point O.

Right asc. of the Sun, 1 Obs.	277° 20′ 23″	
Elong. from the merid.	80° 59′ 30″	*A.*
Right asc. of the midheaven	358° 19′ 53″	
Right asc. of the com., 1 Obs.	46° 24′ 41″	*S.*
Dist. from the *Mes.*, 1 obs.	48° 4′ 48″	Compl. to 360 degr., the ang. Z H O.

1	Log. Z H, compl. of the elev. of the pole	54061			
	Log. of the angle O Z H, azim.	1883 *A.*		earlier observ.	78° 55′
	Log. of the perp. H V	55944		34° 51′ 24″	Log. 55944

	55° 36′ 46″	Hyp., compl. of the declin., observ. 1.	Log. 19209 *S.*	
	of the angle Z O H or G O H, and just as great also is		Log. 36735	43° 50′ 2″ L N H.

2	Interval of time 26^{m} 11^{s}, converted into degr., G L or O N or L H G		6° 32′ 45″ *Subt.* here.
	Distance from the merid. at the earlier observ.		48° 4′ 48″
	Angle Z H N		41° 32′ 3″ only
	1′ 16″ greater than the distance which we had above, composed from the observed one and the diff. of ascens., namely 41° 30′ 51″.		

		Z H, compl. of the elev. of the pole	35° 37′ 8″	
3.	In triang. Z H N are given	N H, compl. of the apparent declin., 1st obs.	55° 36′ 46″	The side Z N is sought.
		Z H N, the included angl.		

Log. Z H	54061		Ant. 20713			
Log. Z H N	41089 *A.*					
Log. of the perp. Z T	95150	22° 42′ 55″	Ant. 8074 *S.*		Ant. 8074	
			Ant. 12639	28° 12′ 13″		
		Compl. of the declin. at the earlier observ.		55° 36′ 46″		
			There remains T N	27° 24′ 33″	Ant. 11906 *A.*	° ′ ″
				Z N	Ant. 19980	35° 1′ 37″
				Its compl. and N P		54° 58′ 23″

522

[Margin: Parallaxis obſervationibus ineſt.] *A parallax is present in the observations.*

Since, therefore, Z N is 36″ greater than the complement of the limited altitude, Z M, there is certainly some parallax in the observations, and the calculation must accordingly be continued.

4.	Log. of the hyp. Z H		54061 *S.*		
	Log. H T	28° 12′ 13″	74949	° ′ ″	
	Log. T Z H		20880	54° 14′ 37″	
	Log. N Z	35° 1′ 37″	55519 *S.*		
	Log. N T	27° 24′ 33″	77579		
	Log. N Z T		22060	53° 19′ 27″	
				107° 34′ 4″	
	Compl. to 180 degr.			72° 25′ 56″	is the angl. B Z P.
	Azim. of the 2nd observ., corr. and limit.			72° 24′ 49″	
	Angle R Z P or L Z N			1′ 7″	

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5.	In the same triangle Z N H let the angle Z N H be sought.				
	Log. of the hyp. N Z		35° 1′ 37″	55519 *S.*	
	Log. T Z		22° 42′ 45″	95150	
	Log. of the ang. Z N T			39631	or Z N H 42° 17′ 0″.

[522] set unruled, in the page's own columns, with short rules under several figures. The marks are printed after 54 15 26, 180, the first time 5 23 58 (as ′ and ″), the first altitude and azimuth, 277 20 23, 78 55, 34 51 24, 55 36 46 in the first calculation, 43 50 2, the interval 26 11 (as ′ and ″), 1 16, 41 30 51, 35 37 8 and 22 42 55; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. In the first two steps "In triang. B A M ex" and "In triang. C A M ex" stand centred between the two given sides. The given sides and angles of triangle Z H O are gathered between tall square brackets, with "Quæritur" and the three quantities sought at the right; the givens of step 3 between curly braces, with "Quæritur latus Z N." at the right. The tags *A.*, *S.*, *Subt.*, the direction tag *Orient. M.*, and the point-letters are the page's own. As printed: the second azimuth in the table of corrected values is set as 72° 24′ 24″, where the azimuth of the second observation, corrected and limited, is set as 72° 24′ 49″ above and below it; and 41° 32′ 3″ is said to be 1′ 16″ greater than 41° 30′ 51″.

[523] set unruled, in the page's own columns, with short rules under several figures. The marks are printed after 28 12 13 only; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The tag *S.* and the point-letters are the page's own. As printed: the logarithm of the angle T Z H is set as 20880.

		Z M, compl. of the apparent altit., 2nd obs., limit.		
6.	In triang. M Z N, from	N Z	35° 1′ 37″	let the side M N be sought.
		R Z P	1′ 7″	

Log. Z M	35° 1′ 1″	55544			Ant. 19949		
Log. of the ang. R Z P		803222 *A.*	′ ″				
Log. of the perp. M X		858766	0′ 38½″		Ant. 0 *S.*		M X Ant. 0.00179
				Z X	Ant. 19949	35° 1′ 1″	
				Side Z N was		35° 1′ 37″	
				Therefore X N		0° 0′ 36″	Ant. 0.00152 *A.*
				M N		0′ 53″	Ant. 0.00331

7	In the same triang., from all the sides now given, the angle Z M N is sought.					
	Log. Z M	35° 1′ 1″	compl. of the apparent limit. altit.		55544 *S.*	
	Log. Z X	35° 1′ 1″	found in part 6		55544	
	Log. of the ang. Z M X				0	90° 0′ 0″
	Log. M N	53″	found in part 6		826662 *S.*	
	Log. N X	36″	found in part 6		865340	° ′ ″
					38678	42° 47′ 4″
	Angl. Z M N or L M N					132° 47′ 4″

8	For the angle M N Z in the same triangle.				
	Log. M N	0′ 53″	826662 *S.*		
	Log. M X	0′ 38½″	858766	° ′ ″	
	Log. of the ang. M N X or M N Z		32104	46° 20′ 6″	
9	Add the angl. Z N H, found in part 5.			42° 17′ 0″	
	Angle M N H			86° 47′ 6″	
	Let the angl. L N H, part 1, be subtracted.			43° 50′ 2″	
	There remains the angl. M N L or M N I			42° 57′ 4″	

10	Log. M N	53″	826662		11. Ant. 0.00300	12. Log. 826662 *S.*
	Log. of the ang. M N L		38364 *A.*			
	Log. of the perp. M I		864026 0′ 36″		Ant. 0.00152 *S.*	
				N I	Ant. 0.00148	0′ 35″ Log. 868157
				Angle N M I		41° 19′ 30″ Log. 14495
			13.	Angl. N M L, part 7.		132° 47′ 4″
				There remains the angl. I M L		91° 27′ 34″
				Compl. to 180 degr.		88° 32′ 26″ I M L

14	Side or perp. M I	0° 0′ 36″	Log. 864026 +	*Ad.*, that is, *S.*
	Of the angle I M L	88° 32′ 26″	Mesol. 366999 —	
	Side I L		Mesol. 497027 +	23′ 52″
			Add N I	0′ 35″
			Parallax of the earlier observ., L N	24′ 27″
	Antil. of the side M I	0′ 36″	0.00152	
	Antil. of the side I L	23′ 52″	2.41000 *Add.*	
	Antil. of the hyp. M L		2.41152	23′ 52″ parall. of the later obs.

524

[Margin: Nunc rursùs nimis magna reperitur parallaxis.] *Now, in turn, the parallax is found far too large.*

[524]set unruled, in the page's own columns, with short rules under several figures. The marks are printed after 35 1 37 (twice), 42 17 0, 35 1 1 (three times), 90 0 0, 53 (twice), 0 53, 0 36 (twice), 0 35 and 23 52 (twice), and over 0 0 36 in step 14; where the marks stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The 0 of 0° 0′ 36″, 0′ 53″, 0′ 38½″, 0′ 36″ and 0′ 35″ is printed. In step 6 the three givens are gathered between curly braces, "6. In triang. M Z N ex" at the left and "quæratur latus M N." at the right. The step figures 11, 12 and 13 are set within the lines, as on the page. The signs + after the logarithm and mesologarithm in step 14 and the dash after the mesologarithm 366999 are the page's own, as are the tags *A.*, *S.*, *Add.* and *Ad.* and the point-letters. As printed: the arc of T Z is set as 22° 42′ 45″; the angle M N H as 86° 47′ 6″, where 46° 20′ 6″ and 42° 17′ 0″ make 88° 37′ 6″; the logarithm of the perpendicular M I as 864026, where 826662 and 38364 make 865026; the antilogarithm of M N in step 11 as 0.00300, against 0.00331 in step 6; and the logarithm of the angle N M I as 14495, where 868157 less 826662 is 41495.

Just as the parallax came out almost too slight from the earlier calculation, so from this one, just completed, it shows itself far too large. From this it is plain that very little trust is to be placed in these calculations. For when the angles are too obtuse and the sides, in turn, are given very small, nothing certain can be drawn out. And to show more clearly that the method of this calculation is very unsteady, we will attempt the same task by resolving entirely different triangles, and with other data; and so you will find that in this way the parallax, hitherto almost twice as large, can be made smaller than the one found earlier from the same observations: this however, could by no means happen if this problem of Regiomontanus rested on solid foundations, that is, if it enjoyed well-proportioned triangles.

[Margin: Aliâ viâ demonſtratur calculum Regiomont.vacillare.] *By another route it is shown that Regiomontanus's calculation is unsteady.*

1	Log. of the hyp. Z N	35° 1′ 37″	part 5.	55419			
	Log. of the ang. N Z L	0° 1′ 7″		803222 *A.*		Antil. 0.00520	
	Log. of the perp. N Y			858641	0′ 38″	Antil. 0.00170	° ′ ″
				Angle Y N Z		Logar. 0.00350	89° 57′ 8″
	Antil. of the hyp. Z N	35° 1′ 37″		19980			
	Antil. of the side Y N	0′ 38″		0 *Subt.*			
	The residue is the antil. Y Z			19980	35° 1′ 37″		

2	Angl., part 8., M N Z	46° 30′ 6″	
	Angl., part 8., M N L	42° 57′ 4″ *S.*	
	There remains the angl. L N Z	3° 33′ 2″ *Subt.*	
	The angle just found	89° 57′ 8″	
	There remains the angl. Y N L	86° 24′ 6″	

3.	Now in the triang. Y N L there are given Y N 4′ 40″ and the angl. Y N L; Y L is sought.				
	Logar. of the side Y N	0° 0′ 38″	859141	*Add.*, that is, *S.*	
			+		
	Mesol. of the ang.	86° 24′ 6″	276644		
			—		
	Mesol. of the side Y L		582497	0° 10′ 9″	Y L
			+		
				35° 1′ 37″	Y Z
				34° 51′ 28″	Z L

				35° 1′ 1″	M Z
4	Antil. L Y	10′ 9″	0.435	9′ 33″	L M, Parall. of the later observ.
	Antil. Y N	0′ 38″	0.002 *Add.*		
	Antil. of the hyp. L N		0.437	10′ 10″	Parallax of the earlier observ., which [?] was to be computed.

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[Margin: Methodo Regiomontani ad diem 31 Dec. & 1 Januarii parallaxes inquiruntur.] *By the method of Regiomontanus the parallaxes for 31 Dec. and 1 January are investigated.*

From this, then, it can be seen that if you proceed by this route, which is equally well founded in geometry, the parallax comes out smaller by a quarter of one degree than the one that was derived by Crüger's route; so it is easy to go astray in this calculation, as we have already shown at sufficient length above. Nevertheless, if one ever wishes to investigate parallaxes following Regiomontanus, it is better to proceed by this latter method that I have handed down.

Although we attribute little to this calculation (however closely it agrees with our earlier ones, and indeed shows a parallax almost smaller still than the earlier, more solid investigations), let us nevertheless add one or two more examples of the same kind, so that by this reasoning too it may become clear how great the parallaxes come out, both for 31 December and for 1 January: larger than those found, or in fact smaller? For lack of observations, however, we shall have to use altitudes subject to refraction, so the refraction must be carefully attended to. Here it should also be noted that the following observations, from which the calculation is to be set up, were made in the western quarter, just as those of the preceding operations were made in the eastern quarter. Hence other, inverted diagrams would indeed be needed as well; but since each calculation arrives at an absurdity, so that it cannot be carried through to the end, we shall rest content with those two preceding figures.

525 set unruled, in the page's own columns, with short rules under several figures. The marks are printed after 35 1 37 at its three places, 0 38 in step 1, 46 30 6, 4 40 in the line of step 3, 0 0 38, 0 10 9, 10 9 and 10 10; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The 0 of 0° 1′ 7″, 0′ 38″ and 0° 0′ 38″ is printed; 9′ 33″ is printed without a degree figure. The sign + after the logarithm and the mesologarithm, and the dash after the mesologarithm of the angle, are the page's own, as are the tags *A.*, *S.*, *Subt.* and *Add.* and the point-letters. As printed: the line of step 3 gives Y N as 4′ 40″, where the calculation uses 0′ 38″; and the logarithm of Y N at 0′ 38″ stands 858641 in step 1 and 859141 in step 3.

Investigation of Parallax III, for 31 December [Inveſtigatio Parall. III. ad diem 31 Decembr.]

1 Obs. at	$3^h\ 37^m\ 26^s$ *m.*	Altit. of the com.	20° 26′ 45″					
		Refract.	3′ 15″					
		Altit. corr.	20° 23′ 30″	Azim.	46° 55′	*Occ. S.*	De-clin.	41° 3′ 7″
							Compl.	48° 56′ 53″

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2 Obs. at	$4^h\ 27^m\ 22^s$ *m.*	Altit. of the com.	15° 41′ 30″					
Differ.	$49^m\ 56^s$	Refract.	5′ 40″					
		Altit. corr.	15° 35′ 50″	Azim.	38° 7″	*Occ S.*	De-clin.	41° 17′ 20″
							Compl.	48° 42′ 40″

1 Obs. right asc. of the comet	40° 39′ 35″	Right asc. of the Sun at the later obs.	281° 10′ 40″		
2 Obs. right asc. of the comet	40° 19′ 35″	Elongat. from the merid.	246° 50′ 30″		
Different. of ascension	20′ 0″	Right asc. of the midheaven	168° 2′ 26″		
		Right asc. of the com. at the 2nd observ.	40° 19′ 35″ *S.*		
		Distance from the merid.	52° 18′ 25″	Compl. to 180 degr.	
		Differ. of ascens.	20′ 0″	*Add.* here in the quad. *Occ. S.*	
		Angle A B C	52° 38′ 25″		

A B	35° 37′ 8″	Log. 54061		Antil. 20713			
Ang. A B C		Log. 22961 *A.*	° ′ ″				
Perpend. A M		Log. 77022	27° 34′ 31″	Antil. 12059 *S.*			
Antil. M C 119851				B M		Antil. 8655	23° 29′ 45″

[526] set unruled, in the page's own columns, with a short rule under the refraction. The marks are printed after the time 37 26, after 20 26 45, after 46 55 and after 41 3 7; the rest are supplied in the house form; no figure is supplied. The time is printed with the angle marks, as 37′ 26″, and is set in the house time form. The tags *m.* and *Occ. S.* are the page's own.

Antil. A M 12059 *A.*	° ′ ″	Compl. of the declin. at the earlier obs.		48° 56′ 53″ *Add.* here.
Antil. A C 131910		74° 29′ 30″ its compl. is	Side M C	72° 26′ 38″
Altitud. of the com., 2 Obs.		15° 30′ 30″ limited, as if it had lacked proper motion.		

[Margin: Altitudo & Azimuth limitat.] *Altitude and azimuth limited.*

1	In the triang. B A M, from	A B	Log. 54061 *S.*	
		M B	Log. 91960	
	Angle M A B		Log. 37899	43° 12′ 2″
2	In the triang. C M A, from	A C	Log. 3709 *S.*	
		C M	Log. 4781	
	Angle C A M		Log. 1072	81° 37′ 30″
	Azimuth at the 2nd obs., as if it had lacked prop. motion.			38° 25′ 28″

The corrected altitudes and azim., therefore [Correctæ igitur altitudines & Azim.]

								H O
1 Obs. at	$3^h\ 37^m\ 26^s$ *m.*	Altit. of the com.	20° 23′ 30″	Azim.	46° 55′ 0″	*Occ. S.*	Let there be sought	H O Z
2 Obs. at	$4^h\ 27^m\ 22^s$ *m.*	Altit. of the com.	15° 30′ 26″	Azim.	38° 27′ 12″	*Occ. S.*		Z H O

Right asc. of the Sun, 1st observ.	281° 8′ 20″	
Elong. from the merid.	234° 21′ 30″	*A.*
Right asc. of the midheaven	155° 29′ 50″	360 degrees cast off.
Right asc. of the com., 1st obs.	40° 39′ 35″	
Distance from the merid.	65° 9′ 45″	Compl. to 180 degr., the angl. Z H O.

1	Log. Z H, compl. of the elev. of the pole	54061			
	Log. of the ang. O Z H, azimuth	31422 *A.*	Observ. 1.	46° 55′	
	Log. of the perp. H V	85483	25° 10′ 24″	Log. 85483	

		Hyp., compl. of the declin., 1st observ.	Log. 28222 *S.*		
		Angl. Z O H or G O H	Log. 57261	34° 20′ 11″, and just as great also is the angle L N H.	

2	Interval of time 49^{m} 56^{s}, converted into degr.		12° 29′ 0″	G L or O N or L H G	*Subt.* here.
	Distance from the mer. at the earlier observat.		65° 9′ 45″		
	Angle Z H N		52° 40′ 45″		

3	In triangle Z H N are given	Z H, compl. of the elev. of the pole	35° 37′ 8″	
		N H, compl. of the apparent declin. at the earlier obs.	48° 56′ 53″	Z N is sought
		Z H N, the included angle	52° 40′ 45″	

Log. Z H	54061			Ant. 20713			
Log. Z H N	22908 *A.*	° ′ ″					
Log. of the perp. Z T	76969	27° 35′ 28″		Ant. 12074 *S.*	° ′ ″	Ant. 12074	
		H T		Ant. 8639	23° 28′ 30″		
		Compl. of the declin. at the earlier obs.			48° 56′ 53″		
		There remains T N			72° 25′ 23″	Ant. 119736 *A.*	° ′ ″
						Z N Ant. 131810	74° 28′ 35″
						Its complement to 90 degr. is N P	15° 31′ 25″

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[Margin: Cur in hoc exemplo nulla detur diverſitas adſpectus.] *Why no parallax occurs in this example.*

Since, however, Z N is less by 55″ than Z M, the complement, that is, of the limited altitude, there is therefore no parallax at all here. For that parallactic triangle L M N vanishes entirely, namely when Z N is less than Z M; and then the comet is, as it were, raised in the opposite direction, since, namely, the observations were made in the west. But if they had been made in the east, there would certainly have been a parallax. You see, then, how accurately this investigation agrees with the earlier ones, although above, for the same day, the 31st, a parallax that was still perceptible was detected.

Investigation of Parallax IV, for 1 January [Inveſtigatio Parall. IV. ad diem 1. Januarii.]

1 Obs. at	$3^{h}\ 26^{m}\ 0^{s}$ *m.*	Altit. of the com.	21° 57′ 0″					
		Refract.	2′ 35″					° ′ ″
		Altit. corr.	21° 54′ 25″	Azim.	46° 10′	*Occ. S.*	De-clin.	42° 39′ 0″
2 Obs. at	$3^{h}\ 44^{m}\ 0^{s}$ *m.*	Altit. of the com.	20° 4′ 30″				Compl.	47° 21′ 0″
	$18^{m}\ 0^{s}$	Refract.	3′ 30″					
		Altit. corr.	20° 1′ 0″	Azim.	43° 9″	*Occ. S.*	De-clin.	42° 38′ 50″
							Compl.	47° 21′ 10″

527the whole page is a worked calculation, set unruled, in the page's own columns, with short rules under several figures. The marks are printed after the hour and minutes and seconds 4 27 22 of the first line (the hour with the degree mark), 15 41 30, 38 and 7 of the first azimuth, 41 17 20, the right ascensions 40 39 35 and 281 10 40, A B 35 37 8, 43 12 2, the first time 37 26 of the corrected values (as ′ and ″), 20 23 30, 46 55 0, 281 8 20, 46 55 in step 1, 25 10 24, 34 20 11, the interval 49 56 (as ′ and ″), 12 29 0 and 35 37 8 in step 3; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The complement 48° 42′ 40″ stands on the line of the first right ascension, at the right under the declination. In steps 1 and 2 "In triang. B A M ex" and "In triang. C M A ex" stand at the left between the two given sides. The three quantities sought, H O, H O Z and Z H O, are gathered at the right of the corrected values within a tall square bracket; the givens of step 3 stand between tall square brackets, with "Z N is sought" at the right. The tags *m.*, *A.*, *S.*, *Add.* and *Subt.*, the direction tags *Occ S.* and *Occ. S.*, and the point-letters are the page's own. As printed: the first azimuth of the second observation is set as 38° 7″, with no minutes figure; the right ascension of the midheaven at the later observation is set as 168° 2′ 26″; the antilogarithm of B M is set as 8655; and the corrected altitude and azimuth of the second observation are set as 15° 30′ 26″ and 38° 27′ 12″, where the limited values above them are 15° 30′ 30″ and 38° 25′ 28″.

1 Obs. right asc. of the comet	39° 15′ 8″	Right asc. of the Sun at the later obs.	282° 15′ 58″	
2 Obs. right asc. of the comet	39° 13′ 58″	Elong. from the merid.	236° 0′ 0″ *A.*	
Diff. of ascens.	1′ 10″	Right asc. of the midheaven	158° 15′ 58″	360 degrees cast off.
		Right asc. of the com. at the 2nd obs.	39° 13′ 58″ *S.*	
		Dist. from the merid.	60° 58′ 0″	Compl. to 180 degr.
		Differ. of ascension	1′ 10″	*Add.* here.
		Angle A B C	60° 59′ 10″	

Log. A B	35° 37′ 8″ 54061		Ant. 20713		
Log. of the angle A B C	13410 *A.*	° ′ ″			
Log. of the perp. A M	67471	30° 37′ 8″	Ant. 15015 *S.*	° ′ ″	
		B M	Ant. 5698	19° 9′ 30″	
Antil. M C 91975			Compl. of the declin. at the earlier obs.	47° 21′ 0″	*Add.* here.
Antil. A M 15015 *A.*			Side M C	66° 30′ 30″	
Antil. A C 106990		69° 56′ 16″			
The compl. is the altit. of the com., 2nd obs.		20° 3′ 44″	limit., as if it had lacked proper motion.		

[Margin: Altitudo & Azimuth Cometæ limit.] *Altitude and azimuth of the comet limited.*

1	In the triang. B M A, from	A B	Log. 54061 *S.*	
		M B	Log. 111419	° ′ ″
	Angle M A B		Log. 57358	34° 17′ 56″
2	In the triang. C M A, from	A C	Log. 6260	
		C M	Log. 8652	
	Angle C A M		Log. 2392	77° 31′ 0″
	Azimuth at the 2nd obs., as if it had lacked prop. motion.			43° 13′ 4″

The corrected altitudes and azim., therefore [Correctæ igitur altitud. & Azim.]

1 Obs. at	$3^h\ 26^m\ 0^s$	Altit. of the com.	21° 54′ 25″	Azim.	46° 10′ 0″	*Occ. Sept.*
2 Obs. at	$3^h\ 44^m\ 0^s$	Altit. of the com.	20° 3′ 41″	Azim.	43° 10′ 30″	*Occ. Sept.*

Right asc. of the Sun, 1st obs.	282° 15′ 8″	
Elong. from the mer.	231° 30′ 0″	
Right asc. of the midheaven	153° 45′ 8″	360 degrees cast off.
Right asc. of the com., 1st obs.	39° 15′ 8″	
Dist. from the m., 1st obs.	65° 30′ 0″	Compl. to 180 degr. is the angle Z H O.

1	Log. Z H, compl. of the elev. of the pole	54061		
	Log. of the ang. O Z H, azim. at the 1st obs.	32662 *A.*	otherwise the compl. is taken.	
	Log. of the perpend. H V	86723	24° 50′ 32″	
	Log. of the compl. of the declin., 1st obs.	30720 *S.*		
	Log. of the ang. Z O H	56003	34° 50′ 0″	or G O H, and just as great also is the angle L N H.

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2	Interval of time 18^m 0^s, converted into degr.	4° 30′ 0″	G L or O N or L H G	is added here
	Dist. from the mer. at the 1st obs., that is, the ang. Z H O	65° 30′ 0″		other-wise *Subt.*
	Angle Z H N	61° 0′ 0″	only 51″ greater than the one we had above from the observed one and the difference of ascens.	

[528] the calculation is set unruled, in the page's own columns, with short rules under several figures. The marks are printed after the time 26 0 of the first observation (as ′ and ″), 21 57 0, 46 10 of the first azimuth, 43 and 9 of the second, the right ascensions 39 15 8 and 282 15 58, A B 35 37 8, 69 56 16, the hour 3 and 26 0 of the corrected values (the hour with the degree mark, the rest as ′ and ″), 21 54 25, 46 10 0, 282 15 8 and 24 50 32; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. The time difference 18 0 is printed without a label, under the minutes and seconds of the second observation. The two complements stand at the right under the declinations, the first on the line of the second observation, the second on the line of the first right ascension. In steps 1 and 2 "In the triang. B M A, from" and "In the triang. C M A, from" stand at the left between the two given sides, which are gathered by tall square brackets. The tags *m.*, *A.*, *S.* and *Add.*, the direction tags *Occ. S.* and *Occ. Sept.*, and the point-letters are the page's own. As printed: the azimuth of the second observation is set as 43° 9″, with no minutes figure; the corrected altitude and azimuth of the second observation are set as 20° 3′ 41″ and 43° 10′ 30″, where the limited values above them are 20° 3′ 44″ and 43° 13′ 4″; and the right ascension of the Sun is 282° 15′ 58″ at the later observation and 282° 15′ 8″ at the first.

		Z H, compl. of the elev. of the pole	35° 37′ 8″	
3	In the triang. Z H N are given	N H, compl. of the apparent declin., 1st obs.	47° 21′ 0″	Z N is sought.
		Z H N, the included angle	61° 0′ 0″	

Log. Z H	54061		Ant. 20713			
Log. Z H N	13397	° ′ ″				
Log. of the perp. Z T	67458	30° 37′ 19″	Ant. 15019 *S.*	° ′ ″	Ant. 15019	
		H T	Ant. 5694	19° 9′ 6″		
Add. here.		Compl. of the declin. at the earlier obs.		47° 21′ 0″		
		There remains T N		66° 30′ 6″	Ant. 91949 *A.*	° ′ ″
					Z N Ant. 106968	69° 56′ 0″
					Its compl. is N P	20° 4′ 0″

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[Margin: Parallaxis penitùsevaneſcit.] *The parallax vanishes completely.*

Since, therefore, Z N is again less by 16″ than Z M, the complement, that is, of the limited altitude, hence the parallax also vanishes entirely here (just as all the earlier, most accurate inquiries also clearly demonstrate); for Z N ought to be greater. For the comet stood in the western quadrant, and in descent. But when the comet is in the eastern quadrant and in ascent, as in the two earlier examples, then Z N always turns out greater than Z M, if some parallax lies hidden.

[Margin: Ritè nunc deductis parallaxibus demonſtrativè probatur quo loco hoc vel illo die Cometa hæſerit.] *Now that the parallaxes have been properly derived, it is proved demonstratively in what place the comet stood on this or that day.*

Let us now at last put an end to these labours of investigating the parallaxes, since, more than enough (I think), from 23 December up to 1 and 4 January,

[529] the calculation is set unruled, in the page's own columns, with short rules under several figures. The marks are printed after the interval 18 0 (as ′ and ″), after 4 30 0, after the 51 of the remark on the angle, and after 35 37 8; where the marks ° ′ ″ stand alone over the arc of the next line, they are set in a cell of their own. The rest are supplied in the house form; no figure is supplied. "Otherwise *Subt.*" stands at the right under "is added here", opened by a printed square bracket. The givens of step 3 stand between tall square brackets, with "Z N is sought" at the right. The tags *A.*, *S.*, *Add.* and *Subt.* and the point-letters are the page's own. As printed: the angle Z H N is said to be only 51″ greater than the angle found above (60° 59′ 10″ on the facing page), where the difference is 50″; and the interval G L is tagged "is added here", where 61° 0′ 0″ is 65° 30′ 0″ less 4° 30′ 0″.

we have examined the parallaxes in the most varied ways, and indeed with every diligence applied, so that a table of parallaxes could be constructed as well as possible for each degree of altitude and for each day of the apparition, and by means of them the true distance of the comet from the Earth could also be ascertained at any time whatever. Once these are known, it will be permissible not only to affirm with probability that the comet stood above the Moon, as was said in Books II and III, but it will also be proved demonstratively hereafter in what place the comet actually stood on this or that day and hour. This is surely the chief thing, which ought to be investigated by all writers on comets and seriously pursued: for the whole dispute among philosophers about the place of comets, aired until now, can be settled completely by that demonstration.

[Margin: Cur Autori haud concesſum fuerit parallaxes diverſorum horizontum explorare?] *Why was it not granted to the author to explore the parallaxes of different horizons?*

[Margin: Quomodo cum aliorum obſervatorum animadverſionibus comparatum fuerit.] *How matters stood with the notes of other observers.*

As for what seems to remain, I would indeed wish, and nothing would truly be more pleasing to me, that I could likewise derive parallaxes from the observations of other astronomers made here and there, and in this way investigate the parallaxes of different horizons with equal diligence and good faith. But however much I desire this, and though I would gladly apply every effort, I would nevertheless undertake this labour in vain at present. For no observations at all, sufficient and accurate enough, have come to hand by whose help this task could have been accomplished. Many observations were indeed made by most distinguished and most practised men in Italy, France and Germany; but with all those observations the case is such (which, however, I wish to be said with their leave) that I consider we can deduce nothing at all accurate from them: one presented observations only in a rough-and-ready way, scarcely indicating the comet's place by reference to a globe; another noted the time of the observation crudely; another, perhaps noting the time precisely enough, observed the comet's place, however, neither by distances nor by altitudes and azimuths; most judged the longitudes and latitudes of the phenomenon with the naked eye, only by stretched threads, that is, from estimated distances: but from all of these, believe me, nothing solid is gained. Indeed, even if one or another suitable observation is available (very few of which, however, are found), another to be joined with it is lacking in turn. For from a single one alone, as is well known, parallaxes can in no way be derived.

[Margin: Plurimæ accuratiſſimæ obſervationes ad calculum requiruntur.] *Very many, most accurate observations are required for the calculation.*

The best and surest observations of all were indeed made elsewhere, for 26 December, when all the diligent investigators of celestial things everywhere, in Germany, France, Italy, Poland, Hungary, etc., and indeed in Asia and Africa, caught the comet in the evening in one and the same straight line with those

two little stars in the foot of Perseus. Yet the smallest part of them observed neither the time exactly enough nor that straight line carefully enough; hence, too, the parallaxes are ascertained only approximately, and that the comet probably, at least, stood above the Moon. But since in Book III the parallaxes of different horizons were drawn from those same observations amply enough, as far as was allowed, and it is not permitted to go further, we must stop here.

[Margin: Quantæ extiterint genuinæ parallaxes Cometæ horizontales?] *How large were the comet's genuine horizontal parallaxes?*

To those who examine, however, and to the fair-minded who weigh, all and each of the horizontal parallaxes found so far for any days whatever of the whole apparition, it is clearly evident that the horizontal parallax on 23 December was not above 30′; on the 26th, not above 18′; on the 27th it did not reach 13′; on the 28th, scarcely 8′ or 9′; on the 30th, scarcely 4′; on 1 January, scarcely 2′; and on 4 January, scarcely 50″; and so on accordingly. Although, if the matter is weighed still more strictly, the parallaxes in the last days of the comet's apparition were still somewhat smaller; indeed, on 1 and 4 January they almost vanished: for the greatest of all that came out at that time was only 16″.

[Margin: Conceditur parallaxin die 4 Januar. extitisſe 52 ſecund.] *It is granted that the parallax on 4 January was 52″.*

Although these results are too certain ever to be denied, let us nevertheless be a little more generous and, as a favour to the Aristotelian sect, grant a somewhat larger parallax about the last days of the apparition: namely, that on the fourth day of January the horizontal parallax was 52″. On this proportion we have also constructed the following table of parallax, namely for every second degree of altitude on each day of the apparition. But what proportion is wholly inherent in these parallaxes we shall refrain from saying in this place, deferring it to where we have proposed to treat of the genuine distance and true place of the comet with respect to its elongation from the Earth, or where we have proposed to treat of the degrees and increments of the comet's velocity.

[Margin: Diſpoſitio Tabulæ parallaxeos.] *Arrangement of the table of parallax.*

The arrangement of this table, moreover, is as follows: the upper border shows the days, the lower the comet's distances from the Earth, in semidiameters and the miles attached to them; while the left-hand column shows the degrees of altitude, and all the rest the comet's vertical parallaxes themselves.

Vertical Parallaxes of the Comet of the Year 1652, from 20 December up to 12 January [Parallaxes Cometæ Anni 1652 Verticales à die 20 Decembris, ad 12 Januarii usque.]

Year 1652	December 20	December 21	December 22	December 23	December 24	December 25	December 26	December 27	December 28	December 29	December 30	December 31
	S.T.	*S.T.*	*S.T.*	*S.T.*	*S.T.*	*S.T.*	*S.T.*	*S.T.*	*S.T.*	*S.T.*	*S.T.*	*S.T.*

Year 1652	December 20	December 21	December 22	December 23	December 24	December 25	December 26	December 27	December 28	December 29	December 30	December 31
Deg. of apparent altit.	110	110	111	114	123	145	189	264	384	562	817	1166
	0 miles	740 miles	180 miles	0 miles	360 miles	640 miles	300 miles	600 miles	240 miles	760 miles	160 miles	20 miles
	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.
Horiz.	31′ 15″	31′ 1″	30′ 55″	30′ 9″	27′ 51″	23′ 35″	18′ 9″	12′ 59″	8′ 57″	6′ 6″	4′ 12″	2′ 57″
2	31′ 14″	31′ 0″	30′ 54″	30′ 8″	27′ 50″	23′ 34″	18′ 9″	12′ 59″	8′ 56″	6′ 6″	4′ 12″	2′ 57″
4	31′ 11″	30′ 56″	30′ 50″	30′ 5″	27′ 47″	23′ 32″	18′ 7″	12′ 57″	8′ 55″	6′ 6″	4′ 12″	2′ 56″
6	31′ 5″	30′ 50″	30′ 45″	29′ 59″	27′ 42″	23′ 28″	18′ 3″	12′ 55″	8′ 54″	6′ 4″	4′ 11″	2′ 56″
8	30′ 57″	30′ 43″	30′ 37″	29′ 52″	27′ 35″	23′ 21″	17′ 59″	12′ 52″	8′ 52″	6′ 3″	4′ 10″	2′ 55″
10	30′ 47″	30′ 32″	30′ 27″	29′ 42″	27′ 26″	23′ 14″	17′ 53″	12′ 47″	8′ 49″	6′ 1″	4′ 9″	2′ 54″
12	30′ 34″	30′ 20″	30′ 14″	29′ 30″	27′ 15″	23′ 4″	17′ 46″	12′ 42″	8′ 45″	5′ 58″	4′ 7″	2′ 53″
14	30′ 19″	30′ 5″	30′ 0″	29′ 16″	27′ 2″	22′ 53″	17′ 37″	12′ 36″	8′ 41″	5′ 56″	4′ 5″	2′ 52″
16	30′ 3″	29′ 49″	29′ 43″	28′ 59″	26′ 47″	22′ 40″	17′ 27″	12′ 29″	8′ 36″	5′ 52″	4′ 3″	2′ 50″
18	29′ 43″	29′ 30″	29′ 24″	28′ 41″	26′ 30″	22′ 26″	17′ 16″	12′ 21″	8′ 31″	5′ 49″	4′ 0″	2′ 48″
20	29′ 22″	29′ 8″	29′ 3″	28′ 20″	26′ 11″	22′ 10″	17′ 4″	12′ 12″	8′ 24″	5′ 44″	3′ 57″	2′ 46″
22	28′ 59″	28′ 45″	28′ 40″	27′ 58″	25′ 50″	21′ 53″	16′ 51″	12′ 3″	8′ 18″	5′ 40″	3′ 54″	2′ 44″
24	28′ 33″	28′ 20″	28′ 14″	27′ 33″	25′ 27″	21′ 34″	16′ 35″	11′ 52″	8′ 10″	5′ 35″	3′ 51″	2′ 42″
26	28′ 5″	27′ 52″	27′ 47″	27′ 6″	25′ 2″	21′ 13″	16′ 19″	11′ 40″	8′ 2″	5′ 29″	3′ 47″	2′ 39″
28	27′ 36″	27′ 23″	27′ 18″	26′ 38″	24′ 36″	20′ 50″	16′ 2″	11′ 28″	7′ 54″	5′ 24″	3′ 43″	2′ 36″
30	27′ 4″	26′ 51″	26′ 46″	26′ 7″	24′ 7″	20′ 26″	15′ 43″	11′ 15″	7′ 45″	5′ 17″	3′ 39″	2′ 33″
32	26′ 30″	26′ 18″	26′ 13″	25′ 34″	23′ 37″	20′ 0″	15′ 24″	11′ 1″	7′ 35″	5′ 11″	3′ 34″	2′ 30″
34	25′ 55″	25′ 43″	25′ 38″	25′ 0″	23′ 6″	19′ 33″	15′ 3″	10′ 46″	7′ 25″	5′ 4″	3′ 29″	2′ 27″
36	25′ 17″	25′ 5″	25′ 1″	24′ 24″	22′ 32″	19′ 5″	14′ 41″	10′ 30″	7′ 14″	4′ 56″	3′ 24″	2′ 23″
38	24′ 38″	24′ 26″	24′ 22″	23′ 46″	21′ 57″	18′ 35″	14′ 18″	10′ 14″	7′ 3″	4′ 49″	3′ 19″	2′ 19″
40	23′ 56″	23′ 45″	23′ 41″	23′ 6″	21′ 20″	18′ 4″	13′ 54″	9′ 57″	6′ 51″	4′ 41″	3′ 13″	2′ 16″
42	23′ 13″	23′ 3″	22′ 58″	22′ 25″	20′ 42″	17′ 32″	13′ 30″	9′ 39″	6′ 39″	4′ 32″	3′ 8″	2′ 11″
44	22′ 29″	22′ 18″	22′ 14″	21′ 42″	20′ 2″	16′ 58″	13′ 4″	9′ 21″	6′ 26″	4′ 24″	3′ 2″	2′ 7″
46	21′ 43″	21′ 32″	21′ 28″	20′ 57″	19′ 21″	16′ 23″	12′ 37″	9′ 1″	6′ 13″	4′ 15″	2′ 55″	2′ 3″
48	20′ 55″	20′ 45″	20′ 41″	20′ 11″	18′ 38″	15′ 47″	12′ 9″	8′ 41″	5′ 59″	4′ 5″	2′ 49″	1′ 58″
50	20′ 5″	19′ 56″	19′ 52″	19′ 23″	17′ 54″	15′ 10″	11′ 40″	8′ 21″	5′ 45″	3′ 56″	2′ 42″	1′ 54″
52	19′ 14″	19′ 6″	19′ 2″	18′ 34″	17′ 9″	14′ 31″	11′ 11″	8′ 0″	5′ 30″	3′ 46″	2′ 35″	1′ 49″
54	18′ 22″	18′ 14″	18′ 10″	17′ 43″	16′ 22″	13′ 52″	10′ 40″	7′ 38″	5′ 15″	3′ 35″	2′ 28″	1′ 44″
56	17′ 29″	17′ 20″	17′ 17″	16′ 52″	15′ 35″	13′ 11″	10′ 9″	7′ 16″	5′ 0″	3′ 25″	2′ 21″	1′ 39″
58	16′ 34″	16′ 26″	16′ 23″	15′ 59″	14′ 46″	12′ 30″	9′ 37″	6′ 53″	4′ 44″	3′ 14″	2′ 14″	1′ 34″
60	15′ 37″	15′ 30″	15′ 27″	15′ 5″	13′ 56″	11′ 48″	9′ 5″	6′ 30″	4′ 28″	3′ 3″	2′ 6″	1′ 28″
62	14′ 40″	14′ 33″	14′ 31″	14′ 9″	13′ 5″	11′ 4″	8′ 31″	6′ 6″	4′ 12″	2′ 52″	1′ 58″	1′ 23″
64	13′ 42″	13′ 36″	13′ 33″	13′ 13″	12′ 13″	10′ 20″	7′ 58″	5′ 42″	3′ 55″	2′ 41″	1′ 51″	1′ 18″
66	12′ 43″	12′ 37″	12′ 34″	12′ 16″	11′ 20″	9′ 36″	7′ 23″	5′ 17″	3′ 38″	2′ 29″	1′ 43″	1′ 12″
68	11′ 42″	11′ 37″	11′ 35″	11′ 18″	10′ 26″	8′ 50″	6′ 48″	4′ 52″	3′ 21″	2′ 17″	1′ 35″	1′ 6″
70	10′ 41″	10′ 36″	10′ 34″	10′ 19″	9′ 32″	8′ 4″	6′ 13″	4′ 27″	3′ 4″	2′ 5″	1′ 26″	1′ 1″
72	9′ 39″	9′ 35″	9′ 33″	9′ 19″	8′ 36″	7′ 17″	5′ 37″	4′ 1″	2′ 46″	1′ 53″	1′ 18″	0′ 55″
74	8′ 37″	8′ 33″	8′ 31″	8′ 19″	7′ 41″	6′ 30″	5′ 0″	3′ 35″	2′ 28″	1′ 41″	1′ 10″	0′ 49″
76	7′ 34″	7′ 30″	7′ 29″	7′ 18″	6′ 44″	5′ 42″	4′ 23″	3′ 9″	2′ 10″	1′ 29″	1′ 1″	0′ 43″
78	6′ 30″	6′ 27″	6′ 26″	6′ 16″	5′ 47″	4′ 54″	3′ 46″	2′ 42″	1′ 52″	1′ 16″	0′ 52″	0′ 37″

Year 1652	December 20	December 21	December 22	December 23	December 24	December 25	December 26	December 27	December 28	December 29	December 30	December 31
80	5′ 26″	5′ 23″	5′ 22″	5′ 14″	4′ 50″	4′ 6″	3′ 9″	2′ 15″	1′ 33″	1′ 4″	0′ 44″	0′ 31″
82	4′ 21″	4′ 19″	4′ 18″	4′ 12″	3′ 53″	3′ 17″	2′ 32″	1′ 48″	1′ 15″	0′ 51″	0′ 35″	0′ 25″
84	3′ 16″	3′ 14″	3′ 14″	3′ 9″	2′ 55″	2′ 28″	1′ 54″	1′ 21″	0′ 56″	0′ 38″	0′ 26″	0′ 18″
86	2′ 11″	2′ 10″	2′ 9″	2′ 6″	1′ 57″	1′ 39″	1′ 16″	0′ 54″	0′ 37″	0′ 26″	0′ 18″	0′ 12″
88	1′ 5″	1′ 5″	1′ 5″	1′ 3″	0′ 58″	0′ 49″	0′ 38″	0′ 27″	0′ 19″	0′ 13″	0′ 9″	0′ 6″

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Vertical Parallaxes of the Comet of the Year 1652, from 20 December up to 12 January [Parallaxes Cometæ Anni 1652 Verticales à die 20 Decembris, ad 12 Januarii usque.]

Year 1653	January 1	January 2	January 3	January 4	January 5	January 6	January 7	January 8	January 9	January 10	January 11	January 12
	S. T.	*S. T.*	*S. T.*	*S. T.*	*S.T.*	*S. T.*	*S. T.*	*S. T.*	*S. T.*	*S. T.*	*S. T.*	*S. T.*
Deg. of apparent altit.	1630	2233	2999	3956	5134	6562	8276	10311	12703	15494	18794	22509
	280 miles	100 miles	440 miles	620 miles	40 miles	760 miles	620 miles	120 miles	700 miles	440 miles	740 miles	240 miles
	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.	Min. Sec.
Horiz.	2′ 7″	1′ 32″	1′ 9″	0′ 52″	0′ 40″	0′ 32″	0′ 25″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″
2	2′ 6″	1′ 32″	1′ 9″	0′ 52″	0′ 40″	0′ 32″	0′ 25″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″
4	2′ 6″	1′ 32″	1′ 9″	0′ 52″	0′ 40″	0′ 31″	0′ 25″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″
6	2′ 6″	1′ 32″	1′ 8″	0′ 52″	0′ 40″	0′ 31″	0′ 25″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″
8	2′ 5″	1′ 31″	1′ 8″	0′ 51″	0′ 40″	0′ 31″	0′ 25″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″
10	2′ 5″	1′ 31″	1′ 8″	0′ 51″	0′ 40″	0′ 31″	0′ 25″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″
12	2′ 4″	1′ 30″	1′ 7″	0′ 51″	0′ 39″	0′ 31″	0′ 24″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″
14	2′ 3″	1′ 30″	1′ 7″	0′ 51″	0′ 39″	0′ 30″	0′ 24″	0′ 19″	0′ 16″	0′ 13″	0′ 11″	0′ 9″
16	2′ 2″	1′ 29″	1′ 6″	0′ 50″	0′ 39″	0′ 30″	0′ 24″	0′ 19″	0′ 16″	0′ 13″	0′ 11″	0′ 9″

530a boxed, ruled table filling the page, under its caption, which stands inside the box. The head of each day column carries, on separate lines, the day, then "S.T.", the distance of the comet from the Earth in semidiameters, then the miles added to it, then the unit line; they are given here as the first five rows. In the label column "Year 1652" stands against the day heads, and the label "Deg. of apparent altit." is printed on three lines beside the distance rows; the label cell of the unit row is empty. The body runs from "Horiz." through the apparent altitudes 2 to 88 by twos, in groups of three separated by short rules; minutes and seconds stand as a pair in each day column and are set here in the house form; every 0 is printed. As printed: the day-27 head sets "S, T." with a comma, and the miles of 28 December are printed without a point after "Mil"; the figures at altitude 10 for 27 December carry a comma between the 1 and the 2 of the minutes, those at altitude 38 for 21 December a point after the minutes, and those at altitude 64 for 23 December a faint comma after the minutes. The caption's range runs to 12 January; the columns on this page end at 31 December, and the catchword announces a continuation overleaf.

Year 1653	January 1	January 2	January 3	January 4	January 5	January 6	January 7	January 8	January 9	January 10	January 11	January 12
18	2′ 0″	1′ 28″	1′ 5″	0′ 50″	0′ 38″	0′ 30″	0′ 24″	0′ 19″	0′ 15″	0′ 13″	0′ 11″	0′ 9″
20	1′ 59″	1′ 27″	1′ 5″	0′ 49″	0′ 38″	0′ 30″	0′ 23″	0′ 19″	0′ 15″	0′ 13″	0′ 11″	0′ 9″
22	1′ 57″	1′ 26″	1′ 4″	0′ 48″	0′ 37″	0′ 29″	0′ 23″	0′ 19″	0′ 15″	0′ 12″	0′ 11″	0′ 9″
24	1′ 56″	1′ 24″	1′ 3″	0′ 48″	0′ 37″	0′ 29″	0′ 23″	0′ 18″	0′ 15″	0′ 12″	0′ 10″	0′ 8″
26	1′ 54″	1′ 23″	1′ 2″	0′ 47″	0′ 36″	0′ 28″	0′ 22″	0′ 18″	0′ 15″	0′ 12″	0′ 10″	0′ 8″
28	1′ 52″	1′ 22″	1′ 1″	0′ 46″	0′ 36″	0′ 28″	0′ 22″	0′ 18″	0′ 15″	0′ 12″	0′ 10″	0′ 8″
30	1′ 50″	1′ 20″	1′ 0″	0′ 45″	0′ 35″	0′ 27″	0′ 22″	0′ 18″	0′ 14″	0′ 12″	0′ 10″	0′ 8″
32	1′ 47″	1′ 18″	0′ 58″	0′ 44″	0′ 34″	0′ 27″	0′ 21″	0′ 17″	0′ 14″	0′ 11″	0′ 9″	0′ 8″
34	1′ 45″	1′ 17″	0′ 57″	0′ 43″	0′ 33″	0′ 26″	0′ 21″	0′ 17″	0′ 14″	0′ 11″	0′ 9″	0′ 8″
36	1′ 42″	1′ 15″	0′ 56″	0′ 42″	0′ 33″	0′ 25″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″	0′ 7″
38	1′ 40″	1′ 13″	0′ 54″	0′ 41″	0′ 32″	0′ 25″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″	0′ 7″
40	1′ 37″	1′ 11″	0′ 53″	0′ 40″	0′ 31″	0′ 24″	0′ 19″	0′ 15″	0′ 13″	0′ 10″	0′ 8″	0′ 7″
42	1′ 34″	1′ 9″	0′ 51″	0′ 39″	0′ 30″	0′ 23″	0′ 19″	0′ 15″	0′ 12″	0′ 10″	0′ 8″	0′ 7″
44	1′ 31″	1′ 6″	0′ 49″	0′ 38″	0′ 29″	0′ 23″	0′ 18″	0′ 14″	0′ 12″	0′ 10″	0′ 8″	0′ 7″
46	1′ 28″	1′ 4″	0′ 48″	0′ 36″	0′ 28″	0′ 22″	0′ 17″	0′ 14″	0′ 12″	0′ 10″	0′ 8″	0′ 7″
48	1′ 25″	1′ 2″	0′ 46″	0′ 35″	0′ 27″	0′ 21″	0′ 17″	0′ 13″	0′ 11″	0′ 9″	0′ 7″	0′ 6″
50	1′ 21″	0′ 59″	0′ 44″	0′ 34″	0′ 26″	0′ 20″	0′ 16″	0′ 13″	0′ 11″	0′ 9″	0′ 7″	0′ 6″
52	1′ 18″	0′ 57″	0′ 42″	0′ 32″	0′ 25″	0′ 19″	0′ 15″	0′ 12″	0′ 10″	0′ 8″	0′ 7″	0′ 6″
54	1′ 15″	0′ 54″	0′ 40″	0′ 31″	0′ 24″	0′ 18″	0′ 15″	0′ 12″	0′ 10″	0′ 8″	0′ 7″	0′ 6″
56	1′ 11″	0′ 52″	0′ 38″	0′ 29″	0′ 22″	0′ 18″	0′ 14″	0′ 11″	0′ 9″	0′ 8″	0′ 6″	0′ 5″
58	1′ 7″	0′ 49″	0′ 36″	0′ 28″	0′ 21″	0′ 17″	0′ 13″	0′ 11″	0′ 9″	0′ 7″	0′ 6″	0′ 5″
60	1′ 3″	0′ 46″	0′ 34″	0′ 26″	0′ 20″	0′ 16″	0′ 13″	0′ 10″	0′ 8″	0′ 7″	0′ 6″	0′ 5″
62	0′ 59″	0′ 43″	0′ 32″	0′ 24″	0′ 19″	0′ 15″	0′ 12″	0′ 9″	0′ 8″	0′ 7″	0′ 6″	0′ 4″
64	0′ 55″	0′ 40″	0′ 30″	0′ 23″	0′ 18″	0′ 14″	0′ 11″	0′ 9″	0′ 7″	0′ 6″	0′ 5″	0′ 4″
66	0′ 51″	0′ 38″	0′ 28″	0′ 21″	0′ 17″	0′ 13″	0′ 10″	0′ 8″	0′ 7″	0′ 6″	0′ 5″	0′ 4″
68	0′ 47″	0′ 35″	0′ 26″	0′ 20″	0′ 15″	0′ 12″	0′ 9″	0′ 8″	0′ 6″	0′ 5″	0′ 4″	0′ 3″
70	0′ 43″	0′ 32″	0′ 24″	0′ 18″	0′ 14″	0′ 11″	0′ 9″	0′ 7″	0′ 6″	0′ 5″	0′ 4″	0′ 3″
72	0′ 39″	0′ 29″	0′ 21″	0′ 16″	0′ 12″	0′ 10″	0′ 8″	0′ 6″	0′ 5″	0′ 4″	0′ 3″	0′ 3″
74	0′ 35″	0′ 25″	0′ 19″	0′ 14″	0′ 11″	0′ 9″	0′ 7″	0′ 6″	0′ 5″	0′ 4″	0′ 3″	0′ 2″
76	0′ 31″	0′ 22″	0′ 17″	0′ 13″	0′ 10″	0′ 8″	0′ 6″	0′ 5″	0′ 4″	0′ 3″	0′ 3″	0′ 2″
78	0′ 26″	0′ 19″	0′ 14″	0′ 11″	0′ 8″	0′ 7″	0′ 5″	0′ 4″	0′ 4″	0′ 3″	0′ 2″	0′ 2″
80	0′ 22″	0′ 16″	0′ 12″	0′ 9″	0′ 7″	0′ 5″	0′ 4″	0′ 4″	0′ 3″	0′ 2″	0′ 2″	0′ 2″
82	0′ 18″	0′ 13″	0′ 10″	0′ 7″	0′ 6″	0′ 4″	0′ 4″	0′ 3″	0′ 3″	0′ 2″	0′ 2″	0′ 1″
84	0′ 13″	0′ 10″	0′ 7″	0′ 5″	0′ 4″	0′ 3″	0′ 3″	0′ 2″	0′ 2″	0′ 1″	0′ 1″	0′ 1″
86	0′ 9″	0′ 6″	0′ 5″	0′ 4″	0′ 3″	0′ 2″	0′ 2″	0′ 1″	0′ 1″	0′ 1″	0′ 1″	0′ 0″
88	0′ 4″	0′ 3″	0′ 2″	0′ 2″	0′ 1″	0′ 1″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″	0′ 0″

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[531] the continuation of the table on the previous page, for 1 to 12 January, set under the same caption, repeated, and in the same form: the day, then "S. T.", the distance of the comet from the Earth in semidiameters and the miles added to it, then the unit line, here given as the first five rows; the altitudes 2 to 88 by twos down the left-hand column, in groups of three separated by short rules. The label column gives the year as 1653. Every 0 is printed. The two pages are set here as two tables, as printed. As printed: the day-5 head sets a point before "Die".

Johannes Hevelius, Cometography, Book Five [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER QUINTUS.]

On the True Place of the Comet and Its Distance from the Earth [De vero Cometæ loco,ejusq; à Terrâ diſtantiâ.]

[Margin: Arduum ſanè eſt negotium cujusvis Cometæ genuinum locum rectè explorare.] *It is indeed an arduous business to ascertain correctly the genuine place of any comet.*

Although correctly determining the true place of any comet is rightly counted among the foremost and indeed most arduous of all the matters that arise concerning comets, nevertheless, since in the preceding books a road has already been laid for us, at sufficient length, toward investigating this very business all the more accurately, and since, God also assenting, the genuine parallaxes of the comet of 1652 have now been duly established for any days of the apparition, it will not be so difficult for us to show in what part of the heavens our comet carried out its motion, and whether, in the course of time, it acquired always the same distance from the Earth, or rather a different one.

[Margin: An Cometa 1652 perpetuò eandem diſtantiam à terrâ conſervaverit?] *Did the comet of 1652 keep the same distance from the Earth throughout?*

In the Second and Third Books it has indeed already been shown with probability that this comet stood neither in the lowest nor in the highest region of the air, but hung, as an ethereal body, in the aether itself, far above the Moon. Now, however, we shall also prove by demonstration by how great an interval it was in fact removed from us.

[Margin: Cometa quotidie à nobis diſcesſit.] *The comet receded from us daily.*

To begin with, it must be understood that, just as the parallaxes diminished from day to day, in like manner the comet itself also became more remote every day, according to that axiom which is above all exception: the smaller the parallax, the more remote the phenomena. By means of this axiom the true seat and the distance of all ethereal bodies are demonstrated and established most exactly.

[Margin: Ordo Planetarum tam in Perigæo quàm Apogæo conſtitutorum.] *The order of the planets placed both at perigee and at apogee.*

Hence, with no one at all contradicting, it is most true that the Moon, on account of its very great horizontal parallax, is, according to each and every one of those skilled in astronomy, the nearest to the Earth of the remaining ethereal bodies, whether it is placed at perigee or at apogee. But with regard to perigee remoteness, once the horizontal parallaxes are properly considered (namely, according to those who acknowledge the Sun, and rightly, as the centre of the whole planetary system), the Moon is followed by Venus; then Mars, Mercury, the Sun, Jupiter, and finally Saturn, which is the most remote of all.

At apogee, however, matters stand very differently with the distances of the planets: for then the Sun itself is the nearest to the Moon, and after it in order follow Mercury, Venus, Mars, Jupiter, and so Saturn.

[Margin: Autores,circa Planetarum Parallaxes,nimiùm quantum inter ſe disſentiunt.] *Authors disagree among themselves exceedingly about the parallaxes of the planets.*

The astronomers, both ancient and more recent, do not, it is true, altogether agree among themselves about the horizontal parallaxes and the distances of the planets; rather, almost as many different opinions are found as there are authors who have written on this matter. And yet this diversity in no way impairs the order of the planets stated above; it only makes this or that planet now nearer, now more distant, as you will see sufficiently from the appended table. In it, following the foremost practitioners of astronomy, namely Ptolemy, Copernicus, Tycho, Kepler, Boulliau, Riccioli, and ourselves as well, you will have both the horizontal parallaxes of all the planets and their distances from the Earth, together, at greatest, mean and least remoteness. The opinions of the others, who seem to differ very little from these, are left aside, since the opinions of so many authors, as you will soon understand, suffice for the business they are to serve.

With the help of this table, too, we shall be able in due course to avoid a great many lengthy discussions, and to understand with almost no trouble how, namely, our comet stood in its parallaxes and distances from the Earth with respect to the planets.

Table showing the distances of the planets from the centre of the Earth, and their horizontal parallaxes, according to the various hypotheses of the astronomers [TABULA exhibens Diſtantias Planetarum à Centro Terræ, eorundemq́; Parallaxes Horizontales, juxta diverſas Aſtronomorum Hypotheſes.]

Planet	Names of the authors	Distance from the Earth, greatest	Horizontal parallax, least	Distance from the Earth, mean	Horizontal parallax, mean	Distance from the Earth, least	Horizontal parallax, greatest
		Semid. ♁	*Mi. Se. Te.*	*Semid.* ♁	*Mi. Se. Te.*	*Semid.* ♁	*Mi. Se. Te.*
Sun	Ptolemy	1210	2′ 51″ 0‴	1168	2′ 56″ 30‴	1126	3′ 4″ 0‴
	Copernicus	1179	2′ 55″ 0‴	1142	3′ 0″ 30‴	1106	3′ 7″ 0‴
	Tycho Brahe	1190	2′ 53″ 10‴	1150	2′ 59″ 20‴	1110	3′ 6″ 0‴
	Kepler	3469	0′ 59″ 28‴	3408	1′ 0″ 32‴	3347	1′ 1″ 38‴
	Boulliau	1486	2′ 19″ 0‴	1460	2′ 21″ 18‴	1434	2′ 24″ 0‴
	Riccioli	7580	0′ 27″ 12‴	7327	0′ 28″ 10‴	7074	0′ 29″ 10‴
	Hevelius	5250	0′ 39″ 17‴	5127	0′ 40″ 0‴	5064	0′ 40″ 44‴
Moon	Ptolemy	64 1/6	53′ 34″ 0‴	59	58′ 16″ 0‴	53 5/6	63′ 51″ 0‴
	Copernicus	68 1/3	50′ 18″ 0‴	60 1/3	56′ 59″ 0‴	52 1/3	65′ 43″ 0‴
	Tycho Brahe	60 3/5	56′ 44″ 0‴	56 1/2	60′ 50″ 0‴	52 1/4	65′ 48″ 0‴
	Kepler	58 9/10	58′ 22″ 0‴	56 3/7	60′ 55″ 0‴	54	63′ 41″ 0‴
	Boulliau	64 1/4	53′ 29″ 0‴	59	58′ 10″ 0‴	54	63′ 45″ 0‴
	Riccioli	64 1/4	53′ 30″ 0‴	59	58′ 16″ 0‴	53 3/4	63′ 55″ 0‴
	Hevelius	58 9/10	58′ 22″ 0‴	56 3/7	60′ 55″ 0‴	54	63′ 41″ 0‴

Planet	Names of the authors	Distance from the Earth, greatest	Horizontal parallax, least	Distance from the Earth, mean	Horizontal parallax, mean	Distance from the Earth, least	Horizontal parallax, greatest
Saturn	Albategn. [al-Battānī], according to Ptolemy	18500	0′ 11″ 10‴	15800	0′ 13″ 0‴	13100	0′ 19″ 12‴
	Copernicus	12215	0′ 16″ 50‴	10477	0′ 19″ 40‴	8739	0′ 23″ 38‴
	Tycho Brahe	12300	0′ 16″ 40‴	10550	0′ 19″ 30‴	8800	0′ 23″ 25‴
	Kepler	37721	0′ 5″ 30‴	32407	0′ 6″ 24‴	27093	0′ 7″ 40‴
	Boulliau	16220	0′ 12″ 43‴	13930	0′ 14″ 48‴	11640	0′ 17″ 43‴
	Riccioli	90155	0′ 2″ 10‴	73000	0′ 2″ 48‴	57743	0′ 3″ 30‴
	Hevelius	57080	0′ 3″ 30‴	49040	0′ 4″ 13‴	41000	0′ 5″ 0‴
Jupiter	al-Battānī	12617	0′ 16″ 20‴	10423	0′ 19″ 50‴	8230	0′ 25″ 0‴
	Copernicus	7375	0′ 27″ 40‴	5960	0′ 34″ 40‴	4545	0′ 45″ 20‴
	Tycho Brahe	7405	0′ 27″ 30‴	5979	0′ 34″ 24‴	4555	0′ 45″ 0‴
	Kepler	22043	0′ 9″ 17‴	17720	0′ 11″ 40‴	13397	0′ 15″ 24‴
	Boulliau	9485	0′ 21″ 45‴	7628	0′ 30″ 6‴	5772	0′ 35″ 45‴
	Riccioli	47552	0′ 4″ 20‴	36500	0′ 5″ 40‴	26441	0′ 7″ 45‴
	Hevelius	33360	0′ 6″ 12‴	26815	0′ 7″ 42‴	20270	0′ 10″ 11‴
Mars	al-Battānī	8005	0′ 25″ 55‴	4584	0′ 45″ 0‴	1163	2′ 57″ 20‴
	Copernicus	3044	1′ 7″ 45‴	1736	1′ 58″ 50‴	427	8′ 3″ 7‴
	Tycho Brahe	3060	1′ 7″ 30‴	1745	1′ 58″ 12‴	430	8′ 0″ 0‴
	Kepler	9042	0′ 22″ 59‴	5142	0′ 40″ 7‴	1242	2′ 46″ 4‴
	Boulliau	3916	0′ 52″ 40‴	2224	1′ 32″ 45‴	533	6′ 27″ 0‴
	Riccioli	21005	0′ 10″ 0‴	11000	0′ 18″ 45‴	2373	1′ 26″ 0‴
	Hevelius	13830	0′ 14″ 55‴	7855	0′ 26″ 16‴	1879	1′ 50″ 54‴
Venus	al-Battānī	1070	3′ 13″ 0‴	618	5′ 34″ 0‴	166	20′ 42″ 30‴
	Copernicus	1987	1′ 43″ 50‴	1142	3′ 0″ 30‴	297	11′ 34″ 30‴
	Tycho Brahe	2000	1′ 43″ 0‴	1150	2′ 59″ 20‴	800	11′ 27″ 0‴
	Kepler	5954	0′ 34″ 39‴	3408	1′ 0″ 32‴	862	3′ 59″ 17‴
	Boulliau	2551	1′ 20″ 50‴	1460	2′ 21″ 18‴	369	9′ 19″ 0‴
	Riccioli	12919	0′ 16″ 0‴	7418	0′ 27″ 50‴	1917	1′ 48″ 0‴
	Hevelius	9009	0′ 23″ 0‴	5157	0′ 40″ 0‴	1304	2′ 38″ 10‴
Mercury	al-Battānī	165	20′ 50″ 0‴	115	29′ 54″ 0‴	65	52′ 54″ 0‴
	Copernicus	1658	2′ 4″ 25‴	1142	3′ 0″ 30‴	626	5′ 29″ 30‴
	Tycho Brahe	1670	2′ 4″ 0‴	1150	2′ 59″ 20‴	630	5′ 27″ 0‴
	Kepler	5069	0′ 40″ 42‴	3408	1′ 0″ 32‴	1747	1′ 58″ 4‴
	Boulliau	2168	1′ 35″ 10‴	1460	2′ 21″ 18‴	752	4′ 34″ 17‴
	Riccioli	10868	0′ 19″ 0‴	7473	0′ 27″ 50‴	4078	0′ 50″ 30‴
	Hevelius	7671	0′ 26″ 53‴	5157	0′ 40″ 0‴	2642	1′ 26″ 16‴

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[532] The planet names stand in a narrow left-hand column, each printed sideways beside its group of seven rows; they are set here in the first row of each group. Distances are in semidiameters of the Earth (*Semid.* with the Earth sign); the parallaxes are in minutes, seconds and thirds of arc. The Moon's fractions are printed as a numerator over a denominator, without a bar.

[Margin: Quemadmodum Cometæ Parallaxes paullatim decreverunt, ſic phænomenum iſtud ſenſim altiùs evaſit.] *As the comet's parallaxes gradually decreased, so this phenomenon gradually rose higher.*

Since, therefore, at the end of the preceding Book IV the table itself of the parallaxes of the comet of the year 1652 has now been presented by us — the parallaxes both horizontal and at every second degree of altitude, duly and accurately computed, and indeed for each and every day of the apparition, namely from 20 December to 12 January — it is plainly evident to us that the parallaxes decreased successively. From this it is rightly concluded that the comet, receding perpetually from the Earth, became higher every day. Further, the table itself also shows how great an interval, on each day, the comet stood removed from the Earth, in semidiameters of the Earth. But so that everything may be set before the eyes still more clearly — namely, how the comet acquired a greater distance day by day — so that you may grasp the increments of its distances at once, as it were at a single glance, and so that it may the more easily be compared with the remaining comets with respect to its motion, I shall insert at this place a separate small table, showing only the horizontal parallaxes of our comet and its distances from the Earth, both in semidiameters of the Earth and in German miles.

[Margin: Parallaxes Cometæ 1652 horizontales,atq; diſtantiæ ejus à terrâ exhibentur.] *The horizontal parallaxes of the comet of 1652, and its distances from the Earth, are presented.*

The first column contains the days of the apparition, the second the horizontal parallaxes; the third and fourth show the interval from the Earth in semidiameters of the Earth and in German miles.

Table of the horizontal parallaxes and of the distances of the comet of the year 1652 and 1653 [Tabula Parall. horizontal. & diſtantiar. Cometæ anni 1652 & 1653.]

Day of the month	Horizontal parallax	Distance from the Earth: semidiameters of the Earth	Distance from the Earth: German miles	German miles, of which 15 make one *mill.* [?]
20 December	31′ 15″	110	0	94600
21	31′ 1″	110	740	95340
22	30′ 55″	111	180	95640
23	30′ 9″	114	0	98040
24	27′ 51″	123	360	106140
25	23′ 35″	145	640	125340
26	18′ 9″	189	300	162840
27	12′ 59″	264	600	227640
28	8′ 57″	384	240	330480
29	6′ 6″	562	760	448080
30	4′ 12″	817	160	702780
31	2′ 57″	1166	20	1002780
1 January	2′ 7″	1630	280	1402080

Day of the month	Horizontal parallax	Distance from the Earth: semidiameters of the Earth	Distance from the Earth: German miles	German miles, of which 15 make one *mill.* [?]
2	1′ 32″	2233	100	1920480
3	1′ 9″	2999	440	2579580
4	0′ 52″	3956	620	3402780
5	0′ 40″	5134	40	4415280
6	0′ 32″	6562	760	5644080
7	0′ 25″	8276	620	7117980
8	0′ 20″	10311	120	8867580
9	0′ 16″	12703	700	10925280
10	0′ 13″	15494	440	13325280
11	0′ 11″	18794	740	16163580
12	0′ 9″	22509	240	19357980

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[Margin: Initiò Cometa Terræ fuit vicinisſimus.] *At the outset the comet was nearest to the Earth.*

It is therefore most certain that on 20 December, namely when it first met our eyes, the comet was nearest to the Earth, and was distant only 110 semidiameters of the Earth. Yet this distance of the comet, although it was the least at that time, was nonetheless evidently far greater than the Moon's. For the Moon, even when placed at apogee and in conjunction or opposition, is never more remote than 65 semidiameters of the Earth; and even supposing that you consider it at quadrature, nonetheless those who, like Riccioli and some other more recent astrosophers [Aſtroſophos], extend the system of the planets furthest, beyond all others, never place it higher than 66 semidiameters of the Earth.

[Margin: Cometa multùm remotior extitit Lunâ, etiam in minori ejus à terrâ diſtantiâ.] *The comet was much more remote than the Moon, even at its lesser distance from the Earth.*

Accordingly, with nothing whatever opposing it, nothing at all is truer than that the comet was much more remote than the Moon; indeed, that even in the place where it was least removed from the Earth it was found to be about twice as high. On 30 December, however, advancing, it reached the orb of Venus — that is, according to the opinion of Kepler, who (if you except Riccioli and ourselves) makes the planets most remote; and this Keplerian opinion, in this proportion, always, in favour of the Peripatetic school, we shall retain.

[Margin: Quâ die Cometa Solis regionem pervaſerit?] *On what day the comet reached the region of the Sun?*

On 1 January the comet reached the sphere of Mercury; by 4 January it had already passed beyond the Sun; by 5 January it had already passed beyond the orb of Mercury, by the 6th that of Venus, and by the 8th that of Mars; finally,

533 The rows stand in groups of three, ruled off from each other. The head "Distance from the Earth" spans the third and fourth columns. The parallaxes are in minutes and seconds of arc.

on 9 January it had reached the heaven of Jupiter, and by the 12th it had crossed almost the whole orb of Jupiter.

[Margin: Quâ dieCometa Jovis orbem attigerit.] *On what day the comet reached the orb of Jupiter.*

But if you prefer to follow our own view, which makes the planets more remote still by far, the comet was nonetheless already moving in the orb of Jupiter at that time, as you will clearly see from the two preceding tables.

[Margin: Quanto intervallo Cometa circa finem à terrâ remotus fuerit.] *How great an interval separated the comet from the Earth towards the end.*

No one, therefore, is so dull of mind as not to see easily that this phenomenon is an entirely ethereal body, since towards the end of its duration it stood removed from the Earth by 15,494 semidiameters of the Earth, that is, 13,324,840 German miles.

[Margin: Vnicum argumentum,pro ſede Cometarum à parallaxibus depromptum, abundè ſufficit, ad convellendas quasvis Peripateticorum opiniones.] *A single argument for the seat of comets, drawn from the parallaxes, is amply sufficient to overturn any opinions of the Peripatetics whatever.*

For this reason I consider it not at all worth the effort to go down into the arena with the Peripatetics themselves, examining and refuting their arguments — although, should the occasion arise, we shall perhaps not refuse to take this task upon ourselves as well. For this single demonstration from the parallaxes, astronomical and geometrical, here brought forward, is worth all the others. It suffices to refute all the opinions of our opponents, and also to establish that our comet dwelt in the highest aether: far indeed above the Moon, Mercury, Venus and the Sun, and even above Mars itself at apogee.

[Margin: Ad Saturnum uſq; Cometa evectus eſt.] *The comet was carried up as far as Saturn.*

Perhaps it was carried up even as far as Saturn. Yet since we did not see the comet any longer than 10 January, and obtained no further observations, we cannot affirm this with so much certainty. Even so, it is not so very contrary to reason that, had the Moon not hindered it with its light (for on that day its apparent diameter was still of notable size), the comet would without any doubt have been seen both for longer and far more remote still; for day by day it rose higher and higher, in a very notable proportion. Indeed, if you follow the proportion of the horizontal parallaxes properly, on 14 January, had the comet lasted until then, its parallax would necessarily have scarcely exceeded 5″, and so, as a consequence, it would have been higher than Saturn itself.

I am therefore quite certain that no one who weighs the matter well and rightly understands the nature of parallaxes will fail to grasp easily what place must be assigned to the comet.

[Margin: Autor minimè dubitat ſe Cl. Ricciolo plenè ſatisfecisſe, & more Mathematico abſolutè ſedem hujus Cometæ demonſtrasſe.] *The author does not doubt in the least that he has fully satisfied the distinguished Riccioli, and has demonstrated the seat of this comet absolutely, in the mathematical manner.*

I also do not doubt in the least that, by demonstrating absolutely the parallaxes of this comet and its distances from the Earth, I have fully satisfied the most learned Riccioli, and that he will therefore gladly concede that the seat of this phenomenon has now been demonstrated by us duly and accurately, and indeed mathematically. For he holds the view that no author whatever has so far demonstrated truly and absolutely, in the mathematical manner — however strenuously they have tried — but only probably, from a hypothesis, that comets stood either above or below the Moon. This is clear from the conclusion of Book VIII, Section I, pages 89, 96, 100 and 117, and above all from conclusions 2 and 3, where he says: *"No comet has yet been demonstrated by a mathematical demonstration to have been absolutely either above or below the Moon."*

[Margin: Quibus hæc nondum ſufficiunt, illi mantiſſæ loco ſibi habeant ea, quæ Rothmannus & Ricciolus de eâdem materiâ pronuntiarunt.] *Those for whom these things do not yet suffice may take, as a makeweight, what Rothmann and Riccioli have pronounced on the same matter.*

But if some of the Peripatetic tribe should still not rest content with these things, and, the parallaxes notwithstanding, should nonetheless defend tooth and nail that the comet was below the Moon and in the region of the air, I have (believe me) absolutely no wish on this occasion to dispute this matter with them at greater length. For since, against those who deny the principles, who scorn sound reasons and persist obstinately in their opinions, what is already done

I would be doing; I would waste my time and gain nothing at all. It is therefore better to send these people away, so that in future they may keep their own affairs to themselves. Meanwhile, however, by way of a finishing flourish, I shall add only the following, which I urge them again and again to weigh well among themselves. First, what the most learned Christoph Rothmann replies to Scaliger on almost the same matter of comets, namely in his description of the comet of the year 1585, page 139: *"But truly,"* he says, *"my Scaliger, this Subtlety of yours — the honour with which you several times dignify Cardano's subtleties — deserves the whip. You insultingly call Homer, the best of poets and approved by all, a 'Greekling'; by what name shall I call you here?*

[Margin: Contra negantem principia non eſt disputandum.] *There is no disputing with one who denies the principles.*

But since there is no disputing with one who is ignorant of the principles, I shall first hand you over to the mathematicians to be taken in hand and instructed, so that you may learn from them what parallax is, and where it comes from. Once you have learned this, my dispute with you will be easy. Indeed, you will then acknowledge your error yourself, to the point of shame, nor will you deny that comets [?] the Moon cling in the spheres."

Likewise the advice which the most skilful Riccioli imparts to men of the same nature in Book VIII, On Comets, Section I, Chapter XVI, page 70 of the *Almagest*: *"We therefore advise these and men of this kind either to steep themselves in the doctrine of parallaxes, and only then to approach this judgement; or, if they*

are unwilling or unable to learn this doctrine thoroughly, to refrain from passing absolute judgement on matters they do not understand, lest they make themselves a laughing-stock to those who do understand.

[Margin: Abſolutum judicium, de Cometarum ſede, Aſtronomis tantùm competit.] *Absolute judgement on the seat of comets belongs to astronomers alone.*

At most, let them dispute about the nature and origin of comets on the hypothesis that it has been demonstrated by the mathematicians that all or some of them are above, or below, the Moon; but let them leave absolute judgement to the astronomers, and defer it to them as to men skilled in their own art — just as Aristotle, in matters that concern astronomy, judged that one should defer to Eudoxus and Callippus [Calippo], and appeal to them in cases of doubt."

[Margin: ConſiliumKeppleri pro hebetioribus.] *Kepler's advice for the duller.*

I also ask them to ponder the advice of the most acute Kepler, which he offers in his introduction, page 9, on the motion of Mars [de Motu Martis], to those who are not endowed with so lively a wit in astronomical matters: *"But whoever is too dull to grasp the science of astronomy, or too weak to believe Copernicus without offence to his piety, I advise to leave the school of astronomy, to condemn, if he likes, any doctrines of the philosophers whatever, and to mind his own affairs; to give up this wandering through the world and go home to cultivate his own little field; and, raising to this visible heaven the eyes with which alone he sees, to pour himself out with his whole heart in thanksgiving and in praise of God the Creator — certain that he renders God no less worship than the astronomer, to whom God has granted that he sees more clearly with the eye of the mind, and who is able and willing himself to celebrate his God over the things he discovers."*

[Margin: Autor,omnes genuinos Cometas in æthere extitiſſe, ſtatuit.] *The author holds that all genuine comets have stood in the aether.*

If our opponents, who fight so strenuously for the camp of Aristotle, observe all this well in future and submit themselves to this advice, I do not doubt that they will one day take on a milder temper, and much more readily agree with us entirely on this question; and that in the end they will concede of their own accord that genuine comets are not sublunary meteors but purely ethereal bodies.

For I am wholly of the view that not only the comet of the year 1652 but all the other true comets as well have stood in the heaven itself. If only our predecessors had left us more accurate observations of comets, from which this very point could have been derived, this dispute would surely have been settled long ago! But, regret- tably, apart from Tycho alone, almost no one has made sufficiently exact observations in this business of comets. We therefore earnestly ask each and every one who is thoroughly practised in this arena [in hoc pulvere; literally, in this dust] to direct their eyes and minds to comets more diligently in future than hitherto, and to measure them with every effort using the most approved instruments. Then it will be plainly evident that all comets move in the highest aether and are of almost the same nature as the

other, eternal planets, with this distinction: that they are only temporary, and as it were pseudo-planets, as will be said more fully in its place.

[Margin: Quoniam Veteres aliquantò negligentiores in deſcribendis Cometis extiterunt, Recentiores Poſteriq́; admonentur,ut diligentiores ſe ſe præbeant.] *Since the ancients were somewhat more careless in describing comets, the moderns and posterity are urged to show themselves more diligent.*

Meanwhile, however, I do not altogether deny that some comets also sometimes pass through the sphere of the Moon, indeed below it, not far from the Earth, as was absolutely the case with the comet of the year 1472. Indeed, I would rather concede that when they advance in the plane of the ecliptic, or are carried toward the Earth by chance, they can at some time graze it and strike into it with their body. But I would have you note that in that case they would appear to us not in the likeness of comets, but by night like a towering and huge fire, and by day like the densest murk. Kepler too holds the same in his *Physiology of Comets* [Cometarum Phyſiologiâ], p. 104, where he says: *Since, then, so many comets pass everywhere through the ethereal expanse, it is not unbelievable that some at times run into the Earth itself as well, and so graze the Earth, or, if they themselves are larger, are as it were pierced through by the Earth. But then they are not seen, as comets usually are, in the guise of a tailed star, but in the guise of a fire by night, or of a murk by day, which sometimes lasts no short time.*

[Margin: Poſſe Ccmetas nonnunquam infra Lunam incedere, imò ipſam Terram attingere.] *That comets can sometimes move below the Moon, and indeed touch the Earth itself.*

[Margin: Quâ ſpecie Cometa videretur, ſi Terram raderet ?] *In what guise would a comet be seen if it grazed the Earth?*

This very thing, which we have just asserted with Kepler, does indeed seem to be a paradox with respect to that assertion so often repeated, namely that no comet is sublunary. But if you rightly grasp our meaning, you will find that both can stand, and that we have by no means been deluded. [Margin: Cometa ſimul ætherem aërēq; nonnunquam trajicere poteſt.] *A comet can sometimes cross the aether and the air together.* For if any one of the comets, with a motion either straight or curved, were to cross the orbs of the planets in such a way that the path of its course passed between the Earth itself and the Moon, then that comet would certainly of necessity enter and pervade our sublunary air; and so it would consequently be rightly said that comets sometimes move even in the air itself, though for a short space of time (as cannot happen otherwise, because of its most rapid passage). But, so that you understand this well: it is one thing for comets arriving from the high aether to cross our air and make for the aether again; it is quite another for comets to be wholly generated and destroyed in the air, and to remain in it for the whole time of their duration, or to complete their course there. [Margin: Nullus Cometa generatur in aëre.] *No comet is generated in the air.* The latter we in no way concede, as will be established at length elsewhere; but the former can happen rather often. So it was observed by Cysat in the comet of the year 1618: namely, that at a certain

time it stood lower than the Moon, but only for a short space of time, so that it was neither born in the region of the air nor ceased to exist in it. On this the same author, in chapter III, proposition VIII, reports as follows about the same comet, p. 60: *The comet advanced in a straight line, such as M L represents; and since this cuts the heaven of the Moon, the comet passed through the outermost sphere of the Moon before December, so that it was perhaps 10 semidiameters nearer to the Earth than the Moon, and hence the least distance of the comet from the Earth would be about 40 semidiameters of the Earth. After 29 December, along the line M L, through the spheres of the planets, the Sun, Mars, etc., to such distances from the Earth, straight upward fled the com- et, so that no parallax could any longer be perceived with our instruments; and, unless it perished first, it pressed on all the way to the firmament.*

Now let us turn to some questions, inquiring first whether each and every comet, as certainly happened in our own comet, likewise departed further and further from the Earth day by day, and continually became higher. Answer: not all comets are entirely alike in this respect, although most have always risen higher from the first beginning of their appearance, as is to be seen in the comet of 1531, of 1585, of 1590, of 1607 and of 1618. But others, like the comet of the year 1533, were higher at first and afterwards approached the Earth more and more. Others were more remote from the Earth at the beginning and toward the end than around the middle of their appearance, as happened in the comet of 1532. The first are always swifter at the beginning of their path, and are afterwards found slower day by day; the intermediate ones are slower at first and swifter at the end; but the last are the swiftest of all in the middle. There can, however, be still others which would seem to vary very little, both in distance and in motion: namely, if they complete their course at a most remote distance from the Earth, through the orbs of the superior planets, Jupiter and Saturn, and indeed around conjunction with the Sun, where they are hidden again by the Sun's rays a little after their first rising, and stay before our eyes for only a short space of time. That all this is so, and also what the genuine reason for these things is, will become better and more clearly evident when we come to speak expressly of the motion and trajectories, to which I refer the reader.

[Margin: An omnes & ſinguli Cometæ à terrâ magis magisq́; removeantur ?] *Whether each and every comet recedes further and further from the Earth?*

[Margin: Singuli ferè Cometarum peculiarem motum exercent; & quâ ratione.] *Almost every one of the comets performs a motion peculiar to itself; and in what manner.*

Second: it is asked whether all comets have fixed bounds or limits of elongation from the Earth, and always recede by an equal interval and proportion. The answer is no. For just as each one of the comets claims for itself an entirely peculiar motion with respect to the regions of the world, both of the ecliptic and of the equator — now one, taking its rise in the north, directs its path toward the south; now another proceeds from east toward west; now another from west to east; now from the south it makes for the north — so likewise

in every comet something singular always appears with respect to its distance from the Earth as well. Now one, coming from a place in the aether far more remote than another, becomes nearer to the Earth; now again it flees to the most remote places. So no one of them all is ever entirely similar to another, neither in motion, nor in trajectory, nor in distance; nor, in our judgement at least, will any come into view in future that will not enjoy peculiar properties, if not in all respects, then at least in some. This very thing can be demonstrated without difficulty once all comets have been skilfully observed, and above all their parallaxes, and the distances derived from them.

[Margin: An omnes Cometæ æquale omninò intervallum à terrâ ac pari velocitate emetiantur ?] *Whether all comets traverse an entirely equal interval from the Earth, and with equal speed?*

[Margin: Nullus unquam Cometarum alter alteri prorsùs ſimilis extitit.] *No one of the comets has ever been entirely similar to another.*

For the comet of the year 1577, when at the start it was nearest to the Earth, had a parallax of 20′; around the middle, 2′ 46″; and around the end, barely 2′. Hence at the beginning it stood 173 semidiameters of the Earth from the Earth; around the middle of its appearance, 1257 semidiameters of the Earth; but around its exit, 1733 semidiameters of the Earth from us, as Tycho fully proved in Book II *de Comet.*, p. 206. The comet of the year 1580, moreover, almost surpassed Saturn in its remoteness, as the same author attests, volume 2, p. 442.

[Margin: Exemplis probatur Cometas diverſimodè à terrâ remotos fuiſſe.] *It is proved by examples that comets have been removed from the Earth in different ways.*

Again, the comet of the year 1585 reached as far as the sphere of the Sun, at the same page cited. But the comet of the year 1607, as Kepler holds on p. 6 concerning that same comet, was never nearer to the Earth than 449 semidiameters of the Earth; at its greatest elongation, however, of 4588 semidiameters of the Earth, it was removed far above the Sun itself. And finally the comet of the year 1618, according to Cysat's calculation, was carried up as far as the sphere of Venus, that is, to 252 semidiameters of the Earth; but according to Crüger, as is evident from his *Uranodromus Cometicus* [Uranodromo Cometico], chapter IX, p. 56, it exceeded 336 semidiameters of the Earth.

[Margin: Quot Semidiametris T. Cometa 1618 à Terrâ diſtiterit ?] *By how many semidiameters of the Earth was the comet of 1618 distant from the Earth?*

Indeed, if we put faith in Kepler, the same comet was plainly thirty times higher than the Moon right at its beginning: for he believes it showed a parallax no greater than 2′, p. 92, *Hist. Comet.* He adds besides in the same place: *At its first appearance it was in the middle space between the orbs of Venus and Mercury; from there it crossed the whole sphere of Venus; the whole space between the orbs of Venus and of the Earth; the whole sphere of the Earth, around 21 December; the whole space between the orbs of the Earth and of Mars; finally the whole orb of Mars, and it passed out into the space between Mars and Jupiter.* So he writes. From this it is clearly deduced that any comet now ascends more and more, now descends

more and more toward the Earth, unless it is hidden by the Sun immediately after its first appearance, or vanishes altogether.

Third: the question arises at this point whether the ascent and descent, or the elongation and approach, of comets with respect to us is entirely equal in all of them; or, what is the same, whether they keep similar degrees of speed and slowness at every time, and always complete their course in an equal interval of time. This, however, is altogether denied. For just as in their distances, so likewise in these respects almost every one of the comets displays something singular, so that none is ever similar to another in every part. For the further the line — the trajectory, that is — stands from the Earth, the more slowly they seem to move; conversely, the nearer the said line is to the Earth, the swifter their motion appears. Add to this that the motion itself, implanted in comets by nature, can greatly increase and diminish these degrees of speed and slowness, as will become more fully plain in its place.

[Margin: An unusquisq; Cometarum diverſos gradus velocitatis & tarditatis ſemper obtineat ?] *Whether each one of the comets always holds different degrees of speed and slowness?*

[Margin: Trajectoriam Cometarum penitùs eſſe inæqualem.] *That the trajectory of comets is altogether unequal.*

We shall show by the following examples that all this happens entirely so: namely, that the motion of comets, or their trajectory, is altogether unequal, and that comets are subject to one variation after another, indeed to almost infinite ones.

1. The comet of the year 1577 traversed 91° 46′ in its orbit from 9 November up to 25 January, that is, in 79 days; but in semidiameters of the Earth, 1560. For at the start it made 173 semidiameters of the Earth, and around its exit 1733 semidiameters of the Earth, daily. Hence it is rightly conjectured that it finally reached about as far as the sphere of Mercury.

[Margin: Exemplis convincitur. 1 Cometâ 1577] *It is proved by examples. 1. By the comet of 1577.*

2. The comet of the year 1585 traversed 39° 21′ in its path from the 18th to 15 November, within 28 days, so that it almost ascended to the Sun itself. Hence, indeed, it is concluded with certainty that this comet was much swifter than the former. Tych. *Ep.* p. 19.

[Margin: Com. 1585.] *Comet of 1585.*

3. It is certain that the comet of the year 1590, which Tycho mentions in *Epist.* p. 181, advanced 42° 10′ in its orbit from 23 February to 6 March, in only eleven days; and nevertheless it extended its trajectory as far as the Sun, indeed above the Sun, since no parallax at all was detected, as Tycho testifies, p. 179, *Epist. ad Landgravium*.

[Margin: Com. 1590.] *Comet of 1590.*

4. The comet of the year 1618, according to Cysat's calculation, from 1 December up to 22 January, in 53 days, although it completed about 85 degrees in the course of its path,

[Margin: Com. 1618.] *Comet of 1618.*

nevertheless barely reached the sphere of Venus; Kepler, however, maintains that it was carried forward as far as Jupiter itself, as you have already learned above.

5. The comet of the year 1607 crossed 97 degrees from 26 September to 26 October, in 31 days, and attained the distance of Venus at its apogee.

[Margin: [[C/G]]om. 1607.] *Comet [?] of 1607.*

6. The comet of the year 1652 completed its course of 65° 51′ in its proper orbit from 20 December to 8 January, in 20 days; on that day it had reached the orb of Mars, and on 9 and 10 January it had already entered the orb of Jupiter, as was demonstrated above, p. 317.

[Margin: Com. 1652.] *Comet of 1652.*

From this it is rightly gathered that each comet has a quite different motion: so that one traverses a larger interval of the heaven in a shorter space of time, while another covers a smaller path in a longer interval of time; one is now higher, now lower, now one lasts longer than another, and so on; so much so that in this respect too one gives way to another in a great many things. The chief cause of this, however, is that almost every one of the comets performs a singular daily motion, both swifter and slower. For the comet that shone in the year 1577 flew through 6° 2′ each day when it was swiftest; the comet of 1585, by contrast, completed only 2° 18′ with its daily motion; the comet of 1590, 7° 34′; the comet of 1607, 9° 40′; the comet of the year 1618, 3° 20′; and the comet of 1652 traversed 11° 16′ in one day. And from this we again find that the daily motion of all comets varied successively: in most it decreased little by little, but in some, conversely, it grew from day to day, as we have already often insisted.

[Margin: Vnusquisq; Cometarum aliquid ſingulare ſibi vendicat; & quare ?] *Each one of the comets claims something singular for itself; and why?*

[Margin: Motus Cometarum diurnus diverſisſimus eſt.] *The daily motion of comets is most diverse.*

But where such a diverse diversity in the decrease and increase of the speed of motion arises from; why this daily motion is not always uniform and equal; likewise whether some regularity, or rather an irregularity, is found in this inequality; and above all why the daily motion is so in some comets at the beginning, in others around the middle, in some around the end, and in some even entirely the contrary: all this, together with many things worth knowing, we are not yet able to explain and demonstrate on this occasion. It must be deferred until we come to unravel the rectilinear and curvilinear motion.

[Margin: An inæqualitati motus diurni aliqua etiam inſit regularitas ?] *Whether some regularity also belongs to the inequality of the daily motion?*

Nothing therefore remains at this point except to add to this Book a small table, in which everything we have said above about the various distances of certain comets from the Earth, their duration, their motion in their proper orbit, and also their greatest daily motion, is set out as if at a single glance.

[Margin: Quorundam Cometarum diſtantiæ duratio & motus exhibentur.] *The distances, duration and motion of certain comets are shown.*

A small table showing the distances of certain notable comets from the Earth, their duration, their motion in their proper orbit and also their greatest daily motion. [Tabella, quorundam inſigniorum Cometarum diſtantias à terrâ, durationem, motum in propriâ orbitâ tum diurnum maximum, oſtendens.]

Comets	Distance from the Earth, S. T.	Duration, days	Motion in its own path (Deg., Min.)	Greatest daily motion (Deg., Min.)	Observers
1577	least 173 S. T.; greatest 1733; as far as the sphere of ☿ [Mercury]	79 days	91° 46′	6° 2′	Tycho
1580	reached higher than ♄ [Saturn]				Tycho
1585	as far as the Sun	28 days	39° 21′	2° 18′	Tycho
1590	was higher than the Sun	11 days	42° 10′	7° 34′	Tycho
1607	least 449; greatest 4588; as far as the apogee of ♀ [Venus]	31 days	97° 0′	9° 40′	Kepler
1618	as far as the sphere of ♀; 252 S. T.; 336 S. T.	53 days	85° *circ.*	3° 20′	Cysat; Crüger
1652	on 20 December, 110; on 8 June, 10311; was above ♂ [Mars], and on the 10th in the sphere of ♃ [Jupiter]	20 days	65° 51′	11° 16′	Hevelius

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Johannes Hevelius, Cometography, Book Six [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER SEXTUS.]

On the Apparent and True Size of the Head and Tail, and on the Light and Colour, both of the Comet of the Year 1652 and of Certain Other Comets [De viſâ & verâ magnitudine Capitis & Caudæ, Lumine & Colore, tam Cometæ anni 1652, quàm aliorum quorundam Cometarum.]

[Margin: Genuina facies Capitis caudæque Stellæ Crinitæ an. 1652.] *The genuine appearance of the head and tail of the hairy star of the year 1652.*

Before we come to the point of being able to compute the true size of the head and tail of our comet of 1652, it is useful first to set down here a particular description of the face with which the head presented itself to our view, both on the first day and on each of the following days. From our general account you have, no doubt, already understood well, if briefly, what we related about this phenomenon: that it had a round body of rare size (namely, on December

[534] in the 1652 row the table prints *Junii*, June, for the 8th; the text above gives this comet's course as running from 20 December to 8 January. The figures 110 and 10311 in the same cell stand as printed.

20), scarcely somewhat smaller than the full Moon; a remarkable and long tail, or beard, of six or seven degrees, directed toward the belt of Orion and the east, that is, turned away from the Sun, and stretching through the star above the foot of Orion, which shone out very brightly in it, almost as far as the star in the hilt of the sword; and that the light of the head was pale, and in part dull, and less splendid, like the Moon covered by a very thin little cloud; while the light of the tail itself, which tapered to a very thin point, was almost rarer still.

[Margin: Dubitat Autor Philoſophos Peripateticos huic obſervationi fidem adhibituros.] *The author doubts that the Peripatetic philosophers will give credence to this observation.*

That these things truly appeared — namely, that its head was not smaller than the body of the Moon, whose diameter contains about 30′ — will scarcely be believed by those who were not given the opportunity of seeing the comet; especially if they examine somewhat more exactly for themselves how great a body that must be whose diameter is given as 30′, not to mention what follows if a comparison is made with the other planets and ethereal bodies. But indeed I frankly confess myself that at the first sight, in the evening at 7^{h} and 8^{h} on December 20, I marvelled not a little at that unusual torch, and indeed stood still, astonished at the novelty of the thing. Truly, had I not watched the comet with these eyes of mine, together with certain learned men who were with me then and were assisting me in the observations, I myself would refuse those things belief. But how much more contrary to reason will it seem to those who are ruled by the preconceived opinions of the Peripatetics, and that comets, out of pure vapours and earthy exhalations, con- sist, contend? Will they not object that even the whole terrestrial globe would in no way suffice to evaporate so much matter? And what of this: that even if the whole globe were resolved into vapours, a body of such astonishing size would still scarcely coalesce out of them?

[Margin: Vt ut nonnulli fortè aliter ſentiant, Cometa tamen Lunam magnitudine ſuperavit.] *However some may perhaps think otherwise, the comet nevertheless surpassed the Moon in size.*

But however much some may judge it far smaller, I nevertheless bid you rest assured that the comet did indeed equal the Moon. In fact, had I measured that phenomenon properly with an instrument, or with some tube, I do not doubt that it would have exceeded the disc of the Moon by a notable amount. Do not suppose, however, that I failed altogether to distinguish that spurious light from the true body, and seized on all the adventitious rays as the true head of the comet. For I would have you know that the whole head of this phenomenon had an even light, not diffusing about the limb but bounding an exact circumference; so that to the naked eye it could not be seen otherwise than as having no livelier light in the middle, except for certain nuclei, like little spots, which could be seen only through the telescope [perspicillo]. This I found more than amply with our larger telescope after some days had passed, as you will soon learn at greater length.

[Margin: ColorCometæ.] *The colour of the comet.*

The colour it displayed, however, was somewhat darkish, dusky and gloomy; not as lively as that of the fixed stars and the planets, but paler still than the light of the Moon itself, although comets are mostly seen glowing red, fiery, and with a twinkling light. Yet it did not show this colour entirely the same at all times; of which more fully below. It is now best to set out first, together with my own, the notes of certain most distinguished observers on this comet, its size and its colour, so that you, judicious reader, may proceed more safely, and that both these reports of mine and what is contained in the general description may earn all the greater credence with you. Above all, since the observations were made and published in different and very remote places, by different observers, with no prior communication, the truth may thereby become known all the more clearly to posterity, to the greater benefit of learning.

[Margin: Wendelini obſervatioCometæ anni 1652.] *Wendelen's observation of the comet of the year 1652.*

1. Govaert Wendelen, a man of remarkable learning, describes this phenomenon in his *Teretologia Cometica* in these words, p. 25: "On December 20, at Tournai [Tornaci], around the eighth hour after noon, my household, going to the neighbours on domestic business, noticed in the sky an unusual but dark light, as of the Moon hidden behind a cloud and shining faintly, etc." Likewise pp. 26 and 27: "On the 21st, at the eighth hour of the evening, I see (he says) near the shield of Orion an unusual light, which was indeed larger than any of the nebulous stars, but shone more faintly, with a pale, boxwood colour, gloomy and dark. And since I knew there was no nebulous star in that place, I perceived, on fixing my gaze more closely [?], that it was in truth a comet, but of a different kind from those I have reviewed and remember having observed. Its size (take note) was such that it either equalled or exceeded the disc of the Moon, etc." (He adds besides in the same place:) "The younger of my nieces, who the day before (as I related above) had seen this new prodigy near the neighbours' houses, added that it had then been much larger, and also of a livelier colour, whereas now it was pale and of a boxwood colour; those who had been present affirmed the same."

[Margin: Cornelii Malvaticæi de eodem Cometâ obſervatio.] *Cornelius Malvaticæus's observation of the same comet.*

2. The most illustrious Cornelius Malvaticæus detected this portent at Bologna [Bononiæ] in almost the same appearance. "At the first hour of the night (namely, by the Italian clock)," he says in his observation published at Padua [Patavii], "on December 21, a comet was found near the stars of the shield of Orion, nebulous and of remarkable size, its diameter almost equal to the semidiameter of the Moon. Through the telescope the whole body did not appear to be of the same character. For in the middle it bore a whitish disc, as the Moon is seen among clouds; and it was as large as the Moon itself appears to the naked eye (note well), and even somewhat larger."

[Margin: D. Chriſtiani obſervatio ejusdem Cometæ.] *D. Christianus's observation of the same comet.*

3. At Giessen [Gisſæ Cattorum] the most learned D. David Christianus (as is evident from his little *Physico-Astronomico-Historical* work, p. 8) recorded it thus on December 8, Old Style: "I noticed (he says) a new phenomenon and an adventitious star, endowed with a dark, rare and nebulous light, which in its whole form was very like that cluster, or heap and conglomeration of stars, which they call the Pleiades; except that from the beginning, around this day and some following days, it seemed somewhat larger than that very cluster (note: for the Pleiades themselves occupy a space of almost one degree in the sky), so that if anyone looked more accurately at its very extremities, it would very nearly equal in apparent size a small disc a span [ſpithamam] in diameter; although, because of the gloomy aspect of its dull light, it by no means presented itself to the eyes as clearly as the planets or the fixed stars, coeval with the world."

[Margin: Obſervatio Cometæ an.1652, Alepi habita à Baſirio.] *Observation of the comet of the year 1652, made at Aleppo by Basirio.*

4. To these three I shall add yet another very notable observation, made in a very remote place, namely at Aleppo [Alepi], by a most excellent physician, an Englishman, that is, Doctor Basirio, if I remember rightly, who described this new phenomenon in almost the same words as ours; at which I marvelled not a little. For he agrees with us so remarkably that you would have sworn that observer had extracted all of it from my notes; which, however, as I know well, never happened, nor perhaps has he ever yet seen anything of mine. The observation itself runs as follows: "On the twentieth day of the month of December of the year 1652, at about the eighth hour of the evening, in the city of Aleppo [Alep], which is in the province of Commagene in the kingdom of Syria, a comet was seen, very notable and of unusual size, for it almost equalled the Moon; somewhat pale in colour, resembling a little cloud lit by the Sun, roundish, yet pointed toward the east and as if bearded. It was first seen in the sign of Gemini, near Regel, or the foot of Orion, at the very beginning of the river Eridanus, making an equilateral triangle with the said Regel and the star at the right leg of the said Orion."

[Margin: Obſervationes inter ſe egregiè conſentiunt.] *The observations agree remarkably with one another.*

I could add more observations of this kind, if there were need, but these, I think, suffice; and from them we have it established clearly enough, and beyond doubt, that I have put forward not dreams and fictions but the very truest things. Nor, surely, could it ever have happened that four different observers, separated from one another by very great distances, one living in Europe, another in Asia, holding entirely different conceptions and possessing different keenness of sight, who never communicated with one another about this matter, should agree so precisely in everything? Truly, unless the matter rested on the naked truth, you would have looked in vain for observations so alike. All of them,

therefore, saw along with me the co- met, on December 20, with exactly the same face: namely, that its head not only approached the size of the full Moon but very nearly exceeded it by a little; likewise, we agree very well among ourselves about its light, its colour and also its beard.

[Margin: CaputCometæ indies decrevit, lumenq́; obſcurius extitit.] *The head of the comet decreased from day to day, and its light became darker.*

On the following days, however, the phenomenon did not keep so great a size steadily; for, as far as the naked eye could tell, it at once decreased very greatly. On December 21 and 22 it was not possible to view the comet at all, because the air was thoroughly turbid; but on the 23rd, although it had by then notably diminished, I nevertheless examined it several times that same night with very large brass instruments, and found that its disc still measured about 25′, 27′ and more. The tail, however, it showed of only 5°. The light and the colour, too, of both the head and the tail appeared much duller and gloomier, almost like those of a nebulous star, although the body itself was still very conspicuous among the other stars.

On December 26 it had decreased more and more; yet the head, as was judged by means of the instruments, still measured 24′ or 23′ in diameter, while the tail appeared only two degrees long.

[Margin: Quali facie Cometa per Teleſcopium apparuerit ?] *With what face did the comet appear through the telescope?*

On December 27, although it had become still smaller and weaker, it nevertheless presented itself very well to view among the stars. The length of the tail was estimated at 4°. Moreover, since the sky favoured us exceedingly that night, I also examined that cometary body with a certain very long optical tube, which among other very distant objects distinctly reveals even the companion of Saturn. With this telescope, however (which otherwise takes in [obtendit] 20′ and more, from which its diameter may roughly be inferred), I could not take in the whole disc. It spread a very dull and feeble light, and in the disc itself, toward the left and toward the tail, it showed four or five small bodies, or nuclei, somewhat denser than the rest of the body, of which two seemed a little larger than the other three; although several other very tiny ones besides presented themselves, scattered here and there in the disc, which nevertheless almost eluded the sight, so that it was not possible to distinguish and draw them properly. Toward the right, however, we noticed a winding and twisting light, much brighter than the rest of the whole body, just as if it were a heap of many very tiny small bodies. Yet this light was not so intense and lively as that of the other fixed stars or of the planets, but a little duller.

[Margin: Obſervationes diei 29 Decem. & ſequentium.] *Observations of December 29 and the following days.*

On the morning of December 29, because the air was full of vapours, we could scarcely make out even the head, let alone the tail, especially since it stood only 14° or 12° above the horizon.

On the evening of December 30 the body, together with the tail itself and the light, had decreased more and more.

On the morning of the 31st it was still decreasing; but the tail, because of its low position with respect to the horizon, did not shine out anywhere at that time.

On January 1 of the following year the comet, as also its tail, was a little brighter, because the sky was very clear.

On January 2 it had indeed diminished still further, but it was nonetheless still quite notable in size: for in diameter 7 or 8 minutes [minuta prima] was what it measured; but its light appeared very weak, like that of some nebulous star.

On the evening of January 3, with the sky very clear, the comet once again, and its tail too, 2° in size and stretching toward the belt of Perseus, presented itself quite distinctly to the eye.

On the morning of January 4 the head was seen just as well as on the previous day, but the tail more dimly. On this occasion I noticed that the tail of this comet always appeared brighter in the evening than in the morning. The reason is this: in the evening it always hung high in the sky, beyond the vapours and the refraction, whereas in the morning it stayed near the horizon, exposed to refractions, and was, as it were, smothered by the vapours.

[Margin: Cauda hujus Cometæ ſemper clarior tempore veſpertino quàm matutino apparuit.] *The tail of this comet always appeared brighter in the evening than in the morning.*

But on the evening of January 6 it could be found nowhere in the sky, because of the presence and brightness of the Moon. On the following morning, the 7th, it did come into view again, though without its tail, which from January 4 onward had vanished entirely because of its extreme rarity; the size of the head was estimated at about 5′.

On January 8 it was still much thinner and rarer, so that it could barely, or not even barely, be made out even with keen attention, not even by those whose sight was otherwise strong.

On January 10 it withdrew itself entirely from the naked eye; but to those armed with a longer telescope it still showed itself to some degree. We therefore found it further attenuated still in respect of its head and its light, yet in size far exceeding the fixed stars, even those of the first rank. Its little body, however, was extremely rare, so much so that no nuclei at all appeared in it any longer: for the matter seemed scattered and very much diluted, just like a shadow, with certain fissures and passages interspersed. All of this, however, was made out with difficulty and [?] equally accurately [difficulter æq; accuratè], as usually happens with spots that are just about to perish.

[Margin: Die 10Januar. 1653 Cometa ultimò obſervatus, & quâ ſpecie.] *On January 10, 1653, the comet was observed for the last time; and in what appearance.*

Month	Day	Apparent diameter of the comet (Min., Sec.)	Month, day	Apparent diameter of the comet (Min., Sec.)
Dec.	20	30′ 0″	Jan. 1	10′ 0″
	21	30′ 0″	2	8′ 0″
	22	29′ 0″	3	7′ 0″
	23	27′ 0″	4	6′ 30″
	24	26′ 0″	5	6′ 0″
	25	25′ 0″	6	5′ 30″
	26	24′ 0″	7	5′ 0″
	27	22′ 0″	8	4′ 40″
	28	20′ 0″	9	4′ 20″
	29	18′ 0″	10	4′ 0″
	30	16′ 0″	11	3′ 45″
	31	13′ 0″	12	3′ 30″

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From these figures, then, we rightly gather how large its apparent diameter was, not only on December 20 but also on each of the following days right up to its extinction: that is, how it decreased day by day in respect of its head, its light and its tail. You will learn all of this still more perfectly, however, from this little table and the accompanying diagram [Schemate]. In the little table you will have the size of the diameter in numbers; in the figure [Schematiſmo], however, the actual proportion of both the body and the tail, and also its head in a somewhat larger aspect, as it was perceived with the telescope on the 27th.

[Margin: Apparens Cometæ diameter quotidie variata eſt.] *The apparent diameter of the comet varied daily.*

[Margin: Genuina Cometæ 1652 effigies.] *A genuine likeness of the comet of 1652.*

Diagram. An engraved plate across the full width of the text block, below the paragraph above. On the right is the comet's round head, edged all round with a fringe of short rays; its disc is hatched with horizontal lines and carries small dark dots and a lighter curving band. From the head's left side a tail of fine crossing lines streams to the left, broad at the head and narrowing toward the plate's left edge. The plate's only inscription is the engraver's signature at its upper left, in a cursive hand, set upside down relative to the text:

- Upper left (inverted): "Autor ſculpsit" — "The author engraved it."; the mark after it is not settled between a full stop and a comma.

No letter, number or other label is engraved on the plate.

Here I should like you to note that it was not only I who noticed these little stars, or nuclei, visible in the disc, but that other distinguished interpreters of the heavens, men able to grasp the nature of things, did so as well as I. Govaert Wendelen informs us of this in his *Teretologia Cometica*, p. 25: namely, that

[535] the table is set in two blocks side by side within a ruled frame. The right block's single column headed *M. D.* holds month and day together. The month is printed only in the first row of each block. Rules divide the rows into groups of three.

the Jesuit Fathers at Mantua observed several stars in the comet. He adds in the same place, on p. 27, that he himself noted quite distinct, very tiny little stars in it. "(For) at the eighth hour," he says, "the comet stood at the lower part of Orion's shield, forming a triangle with the seventh and the eighth star in it, and as it were the boss of that shield, somewhat nearer to the eighth star than to the seventh. But when I go down into my study, get my telescope ready and examine the whole body of that star for some time, I see in it a good number of very tiny little stars, and among them one larger than the rest and oblong, in the middle of the others: you would have said it was some hearth, its wood burnt up, showing its remaining embers with live coals and sparks mixed among them. In short, its face seemed to me the same as that of the earlier comet seen in the year 1618 in the hand of Bootes." So he writes.

[Margin: Caput Cometæ ex nucleis ſive Stellulis conſtitit.] *The head of the comet consisted of nuclei, or little stars.*

[Margin: Idem Cl.Wendelin. animadvertit.] *The distinguished Wendelen noticed the same.*

Perhaps there are more people still, lurking here and there, who saw the comet in this way just as we did; but of them nothing whatever has so far been reported to me, nor have I learned anything. Meanwhile I do not doubt at all that whoever has had a telescope simply of good quality, and has directed his eyes and the tube at the phenomenon, will have found everything really to be so. That very few are found who attest the same things comes about because very few gape after secrets of nature of this kind and take delight in them; and if by chance one or another is still found, they mostly lack telescopes [Tuboſpicilla] capable of celestial things. For instruments of that kind are not on sale in every market, nor are they so easily polished and constructed by any craftsman you please. Add that those who belong to the Peripatetic school, even if they have some telescope at hand, prefer to keep away from that business rather than look into those portents a little more attentively, since they have already firmly settled in their own minds that these are earthly exhalations; they fear that their own eyes might perhaps lead them to doubt, or even to settle on the contrary. Exactly the same thing happened in Italy, as the most celebrated Ismaël Boulliau, our very great friend, reports in a letter written to me in the year 1648 on December 11 [die III. Idib.Decembris]: namely, that at Florence, while he was staying there, there was a physician to the Most Serene Grand Duke of Tuscany, utterly devoted to the Peripatetic philosophy, who at all times absolutely refused to look with his own eyes through the telescope at the bands and spots of Jupiter, fearing that he would be thrown into confusion in his Aristotelian philosophy and in his once-preconceived opinion, or at least be made doubtful. But hear rather the author's very own words: "Further, concerning Jupiter," he says, "what you report became plain to me as true with the tube which the Grand Duke of Tuscany gave me as a gift; and I agree with you. Not only do your observations not allow the surface of that planet to be perfectly smooth, but those which the Most Serene Prince made with

that very long telescope discovered spots on the surface of the body of Jupiter. The school of the Peripatetics, thrown into disorder and defeated by these new experiments, trembles throughout the whole world. But those who have followed its party, so as not to be convicted of treason, refuse to cross over to the camp of truth and shut their eyes; nor

[Margin: Quare non cuivis illud ipſum phænomenon obſervare concesſum fuerit.] *Why not everyone was granted to observe that very phenomenon.*

[Margin: Peripatetici ne turbentur in præconceptâ opinione, obſervationes detrectant.] *The Peripatetics refuse observations, so as not to be disturbed in their preconceived opinion.*

[Margin: Cujus rei exemplum Celeb. Bullialdus in Epiſtolâ deMedico quodam Magn. Duc. Hetruriæ profert.] *The celebrated Boulliau, in a letter, gives an example of this, concerning a certain physician of the Grand Duke of Tuscany.*

[Margin: Litteræ Iſmal[[./,]] Bullialdi.] *The letter of Ismaël Boulliau.*

do they bring themselves to raise them and arm them with the tube, so as to put to flight the vain opinions they have formed beforehand. Take one example for all: a certain Florentine physician, whose services and counsel the Grand Duke uses, and whom he could never induce to look through the telescope himself at the things that, when others reported them, he regarded as trifles. And the physician alleged no other cause or reason to excuse his stupidity, except that, since he adhered firmly to the dogmas of Aristotle and did not wish to depart from them in the least, he feared he would be thrown into confusion by what was put before him; and he dreaded that reasons would be offered him not only for doubting the truth of the Peripatetic doctrine, but also for abandoning it. They do not allow themselves to be persuaded that the Sun is a true and real fire, because their leader [coriphæus] Aristotle, in the books *On the Heavens* (if indeed that inept and insipid work was published by him), asserts that heat is generated by the spheres rubbing against the air."

[Margin: Libros Ariſtotelis de Cœlo ſuppoſititios eſſe, putat Bullialdus.] *Boulliau thinks that Aristotle's books On the Heavens are spurious.*

From this preconceived opinion, I think, it has come about that most of the Peripatetics, although some of them clearly saw the comet at as great a size as was reported above, were nonetheless in no way able to persuade themselves that it had really grown to so great a size: for, once this was granted, their whole philosophy would be overthrown, and many absurdities would take their origin from it, as below, at greater length. For this reason those who follow Aristotle, and are led by authorities rather than by reasons, have preferred to contract the comet's diameter a little rather than to extend it too much. Indeed, so far as I know, not even one of them has appeared who agrees entirely with us, and with the observations above, on its size. Perhaps they thought it was only an adventitious light that had spread itself so widely in a ring; whereas it in fact had a light uniform over the whole disc, so far as the naked eye could judge, as we have already touched on. Others perhaps, for that reason too, deliberately described the comet as somewhat smaller, so as not to seem to go

altogether beyond the limits of comets and to report a portent quite unheard of until now, of a kind that had never appeared either in former times or in our own.

[Margin: Peripatetica Philoſophia planècorrueret, ſi tantamCapitis magnitudinem Cometæ adſcribas.] *The Peripatetic philosophy would collapse entirely if you were to ascribe so great a size of head to the comet.*

But in truth I would have you know, kind reader, that there have at times been comets, though very rarely, of no less immense and astonishing size, and therefore quite remarkable above the rest. For example: first, the comet of the year 400 after the birth of Christ, which Sozomen mentions, Book 8, chap. 4. 2. In the time of the Emperor Maurice, according to Niceph., book 18, chap. 35. 3. In the reign of Charlemagne, namely in the year 814, as the annals of France have it. 4. In the year of Christ 945, under Otto I, as Ludovicus Lavatherus [Ludwig Lavater] reports. 5. In the years 1101, 1106 and 1169, etc. Likewise, in the year of Christ 1200, Haly Ben Rodoan [ʿAlī ibn Riḍwān], when as a young man he was studying astronomy, saw a comet whose solid part appeared three times larger than Venus, and of round shape; and its light, he says, was as great as a quarter of the Moon: Book 2 of the *Quadripartitum*, chap. 9; Cardanus [Girolamo Cardano], text 54. Cardano likewise asserts that in the year 1268 a comet of wonderful size was seen in Scotland for several days around midday (a truly great marvel of a portent). 6. In the year of Christ 1444, Joh. Prætorius relates, a huge comet appeared at the time of the solstice, which terrified mortals. 7. In the year 1556, at the beginning of March, a comet was seen nearly equal to half the Moon, according to Cardano, Book 4, chap. 69, *De varietate*.

[Margin: Et olim immenſæ magnitudinis apparuiſſe Cometas, exemplis probatur.] *That comets of immense size appeared in former times too is proved by examples.*

[Margin: Cometa triplo majorVenere.] *A comet three times larger than Venus.*

[Margin: Cometa æqualis Lunæ dimidio.] *A comet equal to half the Moon.*

These examples clearly confirm that very large comets were seen long ago as well; yet, I admit, both the ancients and the more re-

[Margin: Lunæ autem æqualis nullus Cometarum niſi anni 1652 extitit.] *But no comet has been equal to the Moon except that of the year 1652.*

cent writers record none that reached the size of the Moon in diameter, let alone exceeded it. This, however, I think came about because praiseworthy antiquity, and above all the astronomers themselves, devoted very little careful effort to these matters and neglected much, supposing, that is, that comets were meteors and aerial bodies. Meanwhile, however, Seneca describes one (*Natural Questions*, Book 7, chap. 15) which shone in the year 146 before the birth of Christ, and whose diameter was no smaller than the diameter of the Sun or of the Moon: "After the death of Demetrius, king of Syria," he says, "whose children were Demetrius and Antiochus, a little before the Achaean War, a comet blazed out no smaller than the Sun. At first it was a fiery and ruddy orb,

giving off a light bright enough to overcome the night. Then little by little its size was drawn in, and its brightness faded. Finally it vanished entirely."

[Margin: Cometa non minor Sole illuxit.] *A comet shone no smaller than the Sun.*

It is therefore manifest that in former times too, besides this one of ours, there have been comets of wonderful size; indeed, comets that were much more distinguished in brightness and far more splendid. Yet we cannot deny that such immense and very large phenomena have been rare birds: for, except for these two, you will hardly ever produce another comet that equalled them in respect of the head, much less surpassed them. As for the tail, however, you will find countless ones; indeed, the greatest part of them far outdid ours. And so, again and again, the said comet is on that account rightly numbered among the rarest and most outstanding portents of the world, as much for the size of its body and its distance from the Earth as for its trajectory, so that it deserves not only to be well noted but also to be accurately described by us.

[Margin: Præter duos adeò admirandæ, quoad caput,magnitudinis, nullus unquam apparuit.] *Apart from two, none has ever appeared of so wonderful a size in respect of the head.*

[Margin: Cometa 1652 admirandum prorsùs & inſolitum fuit oſtentum.] *The comet of 1652 was an altogether wonderful and unusual portent.*

Moreover, it is established that not every one of the observers always observed the tail of the comet of the year 1652 as alike and the same in respect of length. This came about, first, because not everyone enjoys the same sharpness of sight: some make things out only when their eyes are brought closer, and are almost blind to things far off, like the short-sighted; others, by contrast, see and judge things set rather far away more easily and distinctly. For this reason not all these various observers found the comet to have had a similar tail. Second, because some perhaps noted the tail in the evening, with the Moon absent, at which time, as we have already touched on, it always appeared somewhat longer and clearer; while others drew the tail in the morning, with the Moon shining, when the comet stood lower, among vapours and refractions, and perhaps also with the air not entirely cleared: at which time the tail is mostly seen smaller and weaker. For in respect of such different positions, and of the state of the air, the comet always seems, as it were, to change its face and its tail (although the tail can also be changed in reality; but we are not speaking of that on this occasion, and it is left to its proper place). Tycho too perceived this very well in the comet of the year 1577: for in Book 2, chap. 9, p. 205, he says: "The apparent length of the tail showed itself in various ways according to the nature of the intervening air, and did not seem to keep a fixed tenor." Cysat noted the same in the comet of the year 1618: namely, that at times even the whole comet can be swallowed up by the vapours, just as happened with ours, that is, when it stood in the western quarter; as one may read in the same author, chap. 7, p. 77, in his description of that comet: "Why," he says, "in the western quarter, that

[Margin: Cur omnes & ſinguli obſervatores, eodem tempore non ejusdē magnitudinis caudā deprehenderint in Com. 1652?] *Why did not every one of the observers find the tail of the same size at the same time in the comet of 1652?*

[Margin: Cauda pro ratione aëris intermedii variatur.] *The tail varies according to the nature of the intervening air.*

[Margin: Cometa quando viſum illudat.] *When a comet deceives the sight.*

is, when it is near the horizon, is the comet not seen? Plainly, it is smothered and extinguished by the vapours, like other nebulous stars; for their rays, weak and most of them secondary, cannot penetrate the denser vapours around the horizon."

Moreover, that the matter stands entirely so — namely, that for the reasons given the tails can vary in different ways, so that even learned men, not to say the unskilled, can easily be deceived in determining and depicting tails — was also maintained by the most learned Marcus Squarcialupus, who discusses it elegantly in his little work on comets, pp. 41 and 42. I shall gladly set down his very words here: "I think, Dudith," he says, "that it cannot be that one and the same comet shows only one colour everywhere. And if the appearance of a comet is uncertain, judgement about the comet will always be suspect. For not only the stars and the hairy stars, but the Moon herself, and the Sun likewise, show various colours according to the varying state of the air. In the highest heaven, when the air is serene, the stars shine and gleam with a certain silvery brightness. If cloud or smoke fills the sky, the air is thickened, and we see the stars through smoke and vapours (which, however, we do not make out at night). Therefore their face appears darkish or reddish. And that is the reason why in summer we see the Moon and the Sun reddening on the horizon. Since, then, the inconstancy of the air is great, as there is not just one condition of sky and winds, I hold [?] that the definite face of a comet, that is, its true colours, can scarcely be made out. What then? Do not different situations of places always have different air? Mountains have a pure sky; valleys an impure and foul one. Dry ground makes the air thin, but wet ground and marshes make it thick, dense and foggy. We have a striking example this year. In the mountains the comet appeared bright, its gleam and splendour plainly silvery, especially in the coma. And Cornelius Gemma calls it bright, silvery, shining most purely. Fabricius, too, the Emperor's mathematician, writes that it was white shading into yellow, bright, and not terrifying. And yet a certain man distinguished for his varied learning, whom you know, writes that it was pitch-coloured, blackish, and like a torch seen through smoke. When I read these words I stopped short in astonishment, until the cause of this appearance occurred to me: namely, that the comet's colour was seen as black because of the thicker air of the place. For in a valley, a marshy place and always *luculento* [?], where Auster [the south wind] and the two winds on either side of it prevail, and which Aquilo, Boreas, Caurus and Favonius do not reach, the air deceives the sight, so that it presents to the eyes squalor in place of gleam, a fiery redness in place of splendour, and a dark, leaden colour in place of brilliance. A sky of

this kind often deceives not a few. And if we see philosophers slip, what will become of the unskilled and the inept, who are by far the greater part? And if the colour of the very great and most brilliant comet (namely, of the year 1577) deceived many, what will be certain in smaller and less bright ones?" Snellius, *de Comet.* p. 34, agrees excellently with this: "We see the tail," he says, "the appendage of comets, not in cloudy weather but in the most serene air, and indeed the larger, the clearer the air itself is." No wonder, then, that observers fixed the tail of our comet too in different ways — a tail that was certainly much duller than that of the comet of the years 1577 and 1618!

[Margin: In delineandis Cometar. caudis, & defcribendis coloribus etiam Viri exercitati nonnunquam facilè hallucinantur.] *In delineating the tails of comets and describing their colours, even practised men are sometimes easily deceived.*

[Margin: Varius aër, varium phænomëni colorem inducit.] *Varying air produces a varying colour in the phenomenon.*

But let us go on to inquire for what further reason the tail appeared to this or that observer now longer, now shorter, now brighter, now duller. Because, third, not all (as I judge) the true of seeing and dis- tinguishing the rarer and darker tails have kept to a method. But, you will say, is some special skill needed to carry out these observations? I should have thought that all who have strong sight could discern tails perfectly well. Most certainly, I say: this business must be approached cautiously and with a certain definite skill. If you do so, believe me, you will see the rather rare and duller tails of comets, and also the smallest and more nebulous fixed stars, far more distinctly, and you will find more quickly in the sky things otherwise scarcely perceptible to the sight. Whoever, therefore, has set out to observe such very thin and very rare bodies in the aether should contemplate those duller objects not with eyes directed fully at them, but with eyes partly oblique, as it were, as if he were directing his gaze to the neighbourhood of the thing. In this way you will certainly find not only that those bodies, otherwise invisible, strike the eyes more readily, but also that you can discern them much more clearly and perfectly — especially those feebler tails: towards what quarter of the sky, that is, and towards what stars they direct and cast them — than if you tried the thing itself with a more direct and quite intent gaze. Aristotle himself saw this well long ago; for in *Meteorologica*, Book 1, chap. 6, 330, he says: "One of the stars in the hip of the Dog had a coma, though a faint and dim one. Those who looked at it with intent eyes found its brightness slight, while those who cast their glance at it gradually, as if in passing, found it rather large." Kepler admits the same in the *Physiologia Cometarum*, p. 117, where he discusses the comet of the year 1607: "At first," he says, "when the tail was of faint light, I could not see it because of the weakness of my eyes; others, however, saw it. For it was not the tail that revealed the comet to me, but the size of a star in a place where I knew there was no fixed star so large. In the morning, however, turned straight upward, it was clear enough. I noted, however, that the tail appeared better with the eyes

directed beside the comet, into its neighbourhood, than if I had looked straight at the head."

[Margin: Quâ ratione obtuſiores & rariuſculæ Cometarum caudæ, minutisſimæq; fixæ accuratè cognoſcantur & deprehendantur.] *How the duller and rather rare tails of comets, and the smallest fixed stars, may be accurately recognised and detected.*

[Margin: Obliquis oculis diſtinctiùs nonnunquam objecta,quàm directis videntur.] *Objects are sometimes seen more distinctly with oblique eyes than with direct ones.*

Various reasons for this are ready to hand. For it is certain and established that the pupils dilate and contract according to the greater or lesser light that strikes or enters the eyes, and also that with the pupils somewhat dilated everything is seen and recognised far more distinctly than with them more contracted. Therefore whoever strives to look at a comet and its paler tail, or any faint object, somewhat obliquely — directing the eyes, that is, to the surrounding aether, towards the darker parts of the sky, as if to avoid letting that light of the phenomenon fall straight into the eyes and contract the pupils more than is right — he, I say, sees more clearly and exactly than someone who looks straight at the comet. For while the latter's pupils are narrowed too much, he is able to grasp or perceive by sight much less, because of that more intense and stronger light: as happens to those who fix their eyes too long on the Sun, a fire, or snow in winter, and who afterwards are half-blind, as it were, to paler and very small things. But before we bring forward anything more about tails, it will be worthwhile to continue with the subject once taken up above, and further to inquire into and compute properly the exactly true size of the adventitious body and its bulk.

[Margin: Ratio, cur ex obliquo adſpectu res nonnunquam clarior & diſtinctior appareat.] *The reason why a thing sometimes appears clearer and more distinct when looked at obliquely.*

[Margin: De genuinâ Cometæ diametro.] *On the true diameter of the comet.*

To determine the diameter correctly in miles or in semidiameters of the Earth, certain data are required: first, namely, the size of the diameter of the comet as seen; second, its distance from the Earth; and third, the shape of the head. The first is established from observation: the diameter of the phenomenon at least equalled the Moon's disc, if it did not exceed it. But although some astronomers suppose the diameter of the Moon at apogee to be 34′, 35′, indeed 36′, let us nevertheless set the comet's diameter on this occasion at no more than 30′, namely for 20 December; for we prefer to be seen to err by defect rather than by excess. Nor, indeed, does it matter much to neglect one minute or another, or to concede it freely to our opponents, since its size will nonetheless grow to an immense amount.

2. The distance of the comet from the Earth for 20 December, however, was derived and shown to have been 110 semidiameters of the Earth [S. T.], one semidiameter of the Earth containing 860 German miles.

[Margin: Diſtantia Cometæ à Terrâ.] *The comet's distance from the Earth.*

3. The shape of the head, as far as could be grasped with the naked eye, appeared almost round, as does that of nearly all comets. Not that comets really always show an absolutely perfect roundness; they are only seen in roughly the same form. For I am fully convinced that if these phenomena were looked at close at hand, they would not present a figure of a circle perfect in every respect, as will become clear from what is to be said below. However that may be, let us suppose, following the common opinion, that the comet was quite round, and on this hypothesis let us now set about the calculation.

[Margin: FiguraCapitis.] *The shape of the head.*

In the diagram that follows, let B D be the comet's apparent diameter of 30 minutes, and A C the comet's distance from the Earth, 110 S. T., that is, 94600 German miles; the triangle to be solved is A C D, right-angled at C. And in this very acute triangle let the two sides A C and A D be equal, since as a result nothing is either taken from this business or added to it. Now if from the given angle C A D, namely the semidiameter of the phenomenon, 15′, and the distance A C, you compute C D: as the whole sine is to the tangent of the angle, so A C, the distance from the Earth, 94600 German miles, will give 412 57/125 miles, namely the semidiameter of the phenomenon; its double gives the whole diameter, 825 miles. The same results from the logarithmic calculation.

[Margin: Methodus calculi, pro inveniendâ Cometæ diametro in mill.] *Method of calculation for finding the comet's diameter in miles.*

Mesolog.	15′ 0″	543452	
Logar.	100 S. T.	950986 *Add.*	
Log. of the semid. sought		994438	
Log. of one semid. of the Earth		921034 *S.*	
Logarith.		73404	48/100 | 00/00 | 12/25 semid. of the Earth, which are to be converted into miles.
Logarith.	86010	15082 *A.*	
Logarith.		88486 — 412 7/10	miles; therefore the whole diam. 825 2/5 miles.

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But, you will say, if we weigh this business a little more accurately, it seems that we have not yet arrived at a perfect measure of the true diameter. For since A C and A D are not parallel, but drawn as if from a centre to different

[536] set unruled in the page's own columns, with a short rule under the second, fourth and sixth figures. The label of the second line prints 100 S. T., where the text gives the distance as 110 S. T.; the figures stand as printed.

points of the diameter of another circle, they cannot both be equal; rather A C, passing through the centre, will necessarily always be longer than the tangent A F. For where a tangent touches the circumference, there the semidiameter of the circle meets the tangent at a right angle: according to Theor. 15, prop. 16, and Theor. 16, prop. 18; likewise the Corollary to Theor. 15, prop. 16, of Euclid III. Therefore in the triangle A F C, A F, as the base, is altogether smaller than A C, the hypotenuse. And for that reason the calculation must be undertaken by another route, although this will detract little from the business; nor does it matter much whether it is some miles larger or

[Margin: Alia fecurior ratio diametrum inveſtigandi.] *Another, safer way of investigating the diameter.*

smaller, that diameter. Nevertheless, let us see no less diligently whether any difference can be noted. When the calculation has been set up in this way and properly carried through, you will find that A F comes to 94,599 miles, so that it is smaller by scarcely one mile than the distance A C from the Earth assumed earlier. From this A F and the angle C A F, 15′, the true semid. F C comes out as 412 13,791/25000; and so the whole diameter is about 825, as above, exceeding the earlier one by scarcely 3/25 of one mile — which certainly comes into no consideration here.

With the true diameter thus found, the circumference of the whole body is also derived with very little trouble. For according to the Archimedean proportion and demonstration — as 7 to 22, or if you prefer, as 100 to 314, or as 1600 to 5041, that is, of the diameter to the circumference — the whole circumference of the comet comes out at 2593 41/175. If half of this, neglecting the fraction [refractione], is multiplied by the semidiameter of the comet found above, 412, the product, 535,174, will be the area of the great circle of the cometary body, namely in square miles.

[Margin: Circumferentia corporis Cometici.] *The circumference of the cometary body.*

Diagram. An engraved plate in a plain rectangular frame, set at the left of the measure beside the narrow column of text that follows, holding three drawings side by side and no caption. On the left, a circle with centre C: a vertical line runs from the top of the circle through C to a point A at the foot of the plate; a horizontal line B D crosses the circle through C; lines run from C to the points E and F on the circle, below B and D; from E and F two long lines descend and converge on A. In the middle, a smaller circle with centre H: a horizontal line d e crosses it through H; lines run from H to f and g on the circle, and from f and g two lines converge on a point c below; two long lines descend from near d and e and touch a large circle at the foot, which carries A at its centre. On the right, a circle with centre H and the same letters d, e, f, g and c as the middle drawing; two long lines descend and enclose a small circle at the foot, which carries B. All the letters printed on the plate were read; there are no others.

- B, C, D, E, F (left drawing): the left and right ends of the horizontal line (B, D), the centre (C), and the points on the circle below them (E, F)
- A (left drawing, foot): the point where the two long lines meet
- d, H, e, f, g, c (middle drawing): the ends of the horizontal line (d, e), the centre (H), the points on the circle (f, g), the point below where two lines meet (c)
- A (middle drawing, foot): inside the large circle
- d, H, e, f, g, c (right drawing): as in the middle drawing
- B (right drawing, foot): inside the small circle
- Autor ſculps. (lower right, engraved script): "The author engraved it."

[Margin: Area totius corporis Cometici in mill.Cubicis.] *The area of the whole cometary body in cubic miles.*

Next, the area of the whole surface, and likewise the bulk, can also be determined without difficulty, provided the body is supposed to be completely round, like a sphere — as most have held until now concerning all the planets and comets. Indeed, the Peripatetic school works hard [alloborat] to establish that this is entirely so, although we think quite otherwise, as we shall shortly prove more fully. But granting that the comet has a spherical shape, the area of the whole convex surface — if, that is, the whole area of the circle is multiplied by four, in the manner customary among geometers — comes out at 2,140,696; a sixth part of this, multiplied by the diameter 825, gives the area of the whole cometary body in cubic miles: 294,345,150. You see, then, that the comet displayed a rare and remarkable size. For whoever had set out to go round it, even supposing he covered 10 miles every day, would nonetheless use up 259 days and 4 hours, or 37 weeks, in completing that whole journey.

[Margin: Quanto dierum intervallo in ſuperficie globi Cometici, ſub circulo maximo, iter conficeretur.] *In what interval of days a journey would be completed on the surface of the cometary globe, along a great circle.*

And yet, however astonishing the size of the comet was by this reckoning so set up, in reality it was nonetheless somewhat larger still, if you look into the matter more deeply; and indeed for two different reasons. 1. It is certain that no spherical or round body which has a definite thickness and which exceeds our pupil in size can be seen under its greatest circle, but always, in proportion to the size of that visible body, only under some smaller one — granting even that the illuminated body is somewhat smaller, or

[Margin: Cometæ ſemper majores ſunt quàm apparent,& unde ?] *Comets are always larger than they appear; and from what cause?*

equal to the illuminating body. 2. The same thing happens even though the illuminating body is larger than the illuminated body, because the illuminating body then illuminates less than half of the illuminated body. And therefore, from these two concurring causes, comets are necessarily always larger in reality than they appear: as is demonstrated from the preceding diagram, but better still from those added here.

Let A be the larger illuminating body, B the smaller, H the illuminated body, and c our eye. The rays drawn from the larger illuminating body A to the body H do touch that same body H at *d* and *e*, a little beyond the half; but the tangents *c f* and *c g*, coming from the eye, take in only a smaller part, the part lying between *f* and *g*; and so no more is seen. In the same way it is clear from the other diagram that not only does the smaller illuminating body illuminate less than half of the illuminated body, but the visual rays also subtend at *f* and *g* a still smaller part of that spherical body: which was to be proved.

But so that we do not linger too long over these subtleties — whether, that is, the comet was a little larger or rather smaller — let us go further and explore what proportion held between the Sun, the Moon and the comet, in respect both of diameter and of solidity. Before that can be done, however, the size of the diameter of the Sun, of the Moon and of the Earth must be known. As for the diameter of the Moon, it contains 495 miles. The diameter of the Sun, according to Kepler, is 22 semidiameters of the Earth, that is, 18,922 German miles; so that the ratio of the Earth to the Moon is as 7 to 2, and of the Earth to the Sun as 1 to 11. But if you want these figures still more exactly, and indeed according to the views of various leading astronomers, here is the little table that follows, from which you will learn all these things with almost no trouble according to Ptolemy, Copernicus, Tycho, Kepler, Boulliau and Riccioli.

[Margin: Proportio diametrorum Solis, Lunæ & Terræ; juxta diverſos autores.] *The ratio of the diameters of the Sun, the Moon and the Earth, according to various authors.*

Table showing the sizes of the Sun and the Moon according to the various artificial hypotheses [Tabula exhib. Quantitat. Solis & Lunæ juxta diverſas Artific.Hypotheſes.]

Names of the authors	Mean distance from the Earth	Apparent diameter	True diameter	Circumference of the disc	Area of the greatest circle in the globe	Area of the convex surface	Solidity of the whole globe
	Semid. terræ.	*Mi.Se.*	*Mill. Germ.*	*Milliar. German.*	*Milliaria Quadrata.*	*Milliaria Quadrata.*	*Milliaria Cubica.*
☉							
Ptolemy	1168	32′ 18″	9438	29650	69959175	279836700	440183.129100
Copernicus	1142	32′ 44″	9351	29379	68676884	274707537	428113.382828
Tycho Brahe	1150	31′ 0″	8916	28002	62419258	249677053	371036.715876
Kepler	3408	30′ 32″	26035	81791	532364048	2129456194	9240207.300266
Boulliau	1460	32′ 52″	12004	37713	113177313	452709253	905720.311768
Riccioli	7327	30′ 37″	58533	183887	2690867370	10763469480	315009079 466180
☽							
Ptolemy	59	33′ 20″	492	1547	190499	761966	62.547172
Copernicus	60 1/3	32′ 49″	495	1555	192464	769855	63.515612

Names of the authors	Mean distance from the Earth	Apparent diameter	True diameter	Circumference of the disc	Area of the greatest circle in the globe	Area of the convex surface	Solidity of the whole globe
Tycho Brahe	56 1/2	34′ 0″	480	1509	181335	725339	58.080350
Kepler	56 1/2	31′ 22″	442	1390	153595	614380	45.259327
Boulliau	59	32′ 35″	481	1513	182072	728286	58 442576
Riccioli	59	30′ 37″	452	1419	160266	640823	48.236880

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Now, further, we must investigate how these bodies, namely the Sun, the Moon and the Earth, stood in relation to our comet in respect of diameter and of solidity. It is evident that the diameter of the Earth amounts to 1720 miles, that of the Moon to 495, and that of the comet to 825; from this it follows that the diameter of the comet has to the diameter of the Moon the ratio of 52 to 25 7/10; to the diameter of the Earth, that of 52 to 100; and to that of the Sun, that of 52 to 1500. That is, the diameter of the comet exceeds the diameter of the Moon 1 22/33 times; that of the Earth, 2 2/33; and the diameter of the Sun, nearly 23 times. If you consider solidity, the comet stands to the Moon as roughly 9 to 1; to the Earth as 9 to 59; and to the Sun as 9 to 204,671. So it appears from this that in respect of its body the comet was nine times larger than the Moon, but 6 5/9 times smaller than the Earth and 22,741 times smaller than the Sun. But I would have you note that this proportion held between those bodies on December 20, when the comet was first beginning to appear to us. So that you may grasp these proportions all the more clearly, however, I have set them out in tables, and indeed according to the various authors, as above. The first shows the ratio of the Moon, the second that of the Earth to the other bodies, the diameter of the Earth being taken, that is, as 1000 parts.

[Margin: Quantitas diametrorum Solis,Lunæ,Terræ &Cometæ.] *The size of the diameters of the Sun, the Moon, the Earth and the comet.*

[Margin: Cometa quoties Lunâ major; Terrâ verò & Sole minor extiterit ?] *How many times was the comet larger than the Moon, but smaller than the Earth and the Sun?*

537 the table runs across the full measure under a ruled title band. The Sun sign and the Moon sign each stand alone in a ruled band across the table, heading the two blocks of six rows; here each is set in the first cell of its own row. The column headings are set in two tiers, the quantity above and its unit below, the unit row given here in italics as printed; the first column carries only its lower heading, "Nomina Autorum.", rendered in the header. The apparent diameters are printed as two figures under "Mi.Se.", minutes and seconds. In the last column a point stands after the sixth figure from the right, and in the Riccioli row of the Sun block and the Boulliau row of the Moon block a space stands in its place. A rule divides the first three rows of each block from the last three. The authors' names are printed in Latin, abbreviated in the Sun block (Ptolem., Copernic., Tych. Brah.) and in full in the Moon block.

Table showing the proportion of the diameters and solidities of the Sun, the Moon, the comet and the Earth according to the various hypotheses of the practitioners [Tabella exhibens Proportionem Diametrorum & ſoliditatum Solis, Lunæ, Cometæ & Terræ ex diverſis artificum hypotheſibus.]

Names of the authors	Diameter of the Earth	Diameter of the Sun	Diameter of the comet	Body of the Earth	Body of the Sun	Body of the comet	According to	Diameter of the Sun	Diameter of the Moon	Diameter of the comet
	In parts of which the true diameter of the ☽ is one, it is:			In bodies of which the solidity of the ☽ equals one, it contains:			In parts of which the diameter of the Earth is 1000, it is:			
Ptolemy	3 1/2	19 1/5	1 2/3	43 *ferè*	7037	5 *fer.*	Ptolemy	5487	286	480
Copernicus	3 1/2	19	1 2/3	42	6740	5 *fer.*	Copernicus	5437	288	
Tycho Brahe	3 3/5	18 1/2	1 5/7	46	6388	5	Tycho	5185	279	
Kepler	4.*ferè*	59	1 7/8	59	204	1626 1/2	Kepler	15135	257	
Boulliau	3 4/7	25	1 5/7	46	15498	5	Boulliau	6979	280	
Riccioli	3 3/4	131	1 5/6	55	653	0466	Riccioli	34030	262	

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On each of the following days, however (since the apparent diameter of the comet decreased from day to day as its distance from the Earth grew again), both its true diameter and its proportion to the Moon, the Earth and the Sun will show themselves quite otherwise. But whether the apparent diameter of the phenomenon was really increased, or rather diminished on account of the distance, must be weighed and investigated somewhat more exactly. This will not only bring much pleasure, but will also be of great use in resolving extremely difficult questions, especially when we come to speak of the origin and end of comets.

538 the table stands in one frame across the full measure and into the left margin. Under the title, two blocks stand side by side with an empty space between them: the left block holds the authors' names and six columns; the right block, under its own group heading, holds the authors' names again, in the genitive (Ptolemæi, Copernici, Tychonis, Keppleri, Bullialdi, Riccioli), headed "Ex ſententiâ", and three columns. The three group headings, each spanning three columns, are given here in the second row. A double vertical rule divides the diameters from the bodies in the left block. A rule divides the first three rows from the last three. The last column carries a figure in the first row only. *ferè* and *fer.* ("nearly") are printed in italics beside the figures.

[Margin: An diameter Cometæ apparens reverà; an verò ratione intervalli ſolummodò indies decreverit ?] *Whether the apparent diameter of the comet decreased from day to day in reality, or only on account of the distance?*

But so as not to keep the kind reader's mind in suspense with a long calculation (one already made abundantly clear from what precedes, and which here must proceed along a similar route, with only the comet's diameter and distance varied for each day), I shall therefore at once set before your eyes, for each day, in particular tables, not only the proportion of the comet's size, according to its various distances from the Earth, to the size of the Earth, and likewise of the Sun and the Moon, from the Keplerian hypotheses; but also how, as the apparent diameter and the distance varied, both the true diameter, the area of the circumference of the circle and of the convex surface, and the solidity of the globe itself turned out differently from day to day.

[Margin: Singulis diebus diverſam magnitudinem poſſedit.] *It had a different size on each day.*

The proportion of the comet's size, according to its various distances from the Earth, to the size of the Earth, and likewise of the Sun and the Moon, from the Keplerian hypotheses [Proportio Magnitudinis Cometæ juxta varias ejus à Terrâ Diſtantias, Ad Quantitatem Terræ,itemq́; Solis & Lunæ ex Hypotheſibus-Kepplerianis.]

Day of the appearance	Distance of the comet from the Earth in semidiameters of the Earth	Diameter of the comet in parts of which the diameter of the ☽ is 1000	Diameter of the comet in parts of which the diameter of the Earth is 1000	Diameter of the comet in parts of which the diameter of the ☉ is 1000	Diameter of the comet in parts of which the diameter of the ☽ is 1, of the Earth 4, of the ☉ 59	Solidity of the comet's body in cubic bodies of which the solidity of the ☽ is 1, of the Earth 59, of the ☉ 204162
20 21 Dec.	110 110	1868	480	32	1 7/8	6
22	111	1821	468	31	1 5/6	6
23	114	1805	464	31	1 4/5	6
24 Dec.	124	1829	469	31	1 5/6	6
25	146	2066	531	35	2	9
26	189	2568	660	44	2 4/7	16
27 Dec.	265	3401	874	58	3 2/5	39
28	384	4346	1117	74	4 1/3	82
29	562	5724	1471	97	5 3/4	192
30 Dec.	817	7397	1901	126	7 2/5	404
31	1166	8574	2204	146	8 4/7	631
1 Jan.	1630	9226	2371	157	9 1/4	785
2 Jan.	2233	10109	2598	172	10	1032
3	3000	11883	3054	201	11 1/5	1681
4	3957	14556	3741	247	14 4/7	3085

Day of the appearance	Distance of the comet from the Earth in semidiameters of the Earth	Diameter of the comet in parts of which the diameter of the ☽ is 1000	Diameter of the comet in parts of which the diameter of the Earth is 1000	Diameter of the comet in parts of which the diameter of the ☉ is 1000	Diameter of the comet in parts of which the diameter of the ☽ is 1, of the Earth 4, of the ☉ 59	Solidity of the comet's body in cubic bodies of which the solidity of the ☽ is 1, of the Earth 59, of the ☉ 204162
5 Jan.	5134	17440	4482	296	17 3/7	5288
6	6563	20428	5250	347	20 2/5	8507
7	8277	23424	6020	398	23 2/5	12853
8 Jan.	10311	27237	7000	463	27 1/4	20178
9	12704	31152	8006	529	31 1/7	30208
10	15495	35058	9015	595	35	43085
11 Jan.	18795	39689	10200	674	29 2/3	62611
12	22509	44591	11460	757	44 [?]/5	88493

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How great a size of diameter and of body the comet had on each day, at its various distances from the Earth [Quantam magnitudinem diametri corporisq́; Cometa ſingulis diebus,in diversâ iſtâ à Terrâ diſtantiâ habuerit.]

	Distance of the comet from the Earth	Apparent diameter	True diameter	Circumference of the disc	Area of the greatest circle	Area of the convex surface	Solidity of the whole globe
	Semidiametri Terræ.	*Min. Sec.*	*Milliaria Germanica.*	*Milliaria Germanica*	*Mill. Germ. Quadrata.*	*Milliaria Quadrat.*	*Milliaria Germanic. Cubica.*
20 21 Dec.	110 110	30′ 0″	825	2593	535174	2140696	294345150
22	111	29′ 0″	804	2530	508530	2034120	272572100
23	114	28′ 0″	800	2510	502000	2008000	267730000
24 Dec.	124	26′ 0″	806	2534	510600	2042404	274362900
25	146	25′ 0″	914	2870	655795	2623180	399597700
26	189	24′ 0″	1134	3564	1010394	4041576	763857900
27 Dec.	265	22′ 0″	1502	4720	1772360	7089440	1774723100
28	384	20′ 0″	1920	6036	2897280	11589120	3708518400
29	562	18′ 0″	2530	7974	5043555	20174220	8506796100
30 Dec.	817	16′ 0″	3270	10274	8398995	33595980	18309809100

539 the table stands under its two-line title in a ruled frame, a double vertical rule dividing the first five columns from the last two. In the first row the dates 20 and 21 are set small, one above the other, in the height of a single row, and the distance column holds 110 above 110, joined by a brace; each other column of that row holds a single figure. The rows stand in blocks of three divided by rules, the month named in the first row of each block. In the last row the numerator of the fraction in the sixth column is not settled between 3 and 2.

	Distance of the comet from the Earth	Apparent diameter	True diameter	Circumference of the disc	Area of the greatest circle	Area of the convex surface	Solidity of the whole globe
31	1166	13′ 0″	3792	11912	11292576	45170304	28547632000
1 January	1630	10′ 0″	4078	12810	13066200	52264400	35539792000
2	2233	8′ 0″	4468	14040	15682680	62730720	46713476000
3	3000	7′ 0″	5260	16504	21702760	86811040	76104345000
4	3957	6′ 30″	6440	20200	32522000	130088000	139627787000
5 January	5134	6′ 0″	7700	24220	46623500	186494000	239334000000
6	6563	5′ 30″	9020	28400	64042000	256168000	385105893000
7	8277	5′ 0″	10360	32520	84226800	336907200	581726432000
8 January	10311	4′ 40″	12040	37800	113776000	455104000	913242027000
9	12704	4′ 20″	13780	43200	148824000	595296000	1367196480000
10	15495	4′ 0″	15500	48700	188712500	754850000	1950029170000
11 January	18795	3′ 45″	17560	55140	242064600	968258400	2833769584000
12	22509	3′ 30″	19640	61920	304956000	1219824000	4005088800000

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From these tables it is clearly seen that, although from day to day the comet was more and more notably diminished as to its apparent diameter, from 30′ to nearly 5′, and also became much fainter and duller from day to day, so that around its last appearance it almost escaped sight, nevertheless from December 23 it grew as to its true diameter, circumference and solidity, and increased wonderfully every day: whereas, indeed according to your view, exactly the opposite ought to have happened. For its apparent diameter, found on December 23 to be only 800 miles, already exceeded the size of the Earth's diameter on the 28th of the same month; on January 30 it was larger than Jupiter; and on January 4 it already surpassed Saturn in size. Finally, toward the end of its appearance, it came nearly to the size of the Sun. Rightly, then, is this phenomenon held to be a body of unusual and astonishing size, since

[540] the second table follows the first inside the same frame, under its title set in a ruled band across the full width. The column headings are set in two tiers, the quantity above and its unit below, the unit row given here in italics as printed: semidiameters of the Earth; minutes and seconds; German miles; square German miles; square miles; cubic German miles. The first column has no heading. The apparent diameters are printed as two figures under "Min." and "Sec.". In the first row the dates 20 and 21, and the distances 110 and 110, are set small, one above the other, in the height of a single row, the distances joined by a brace. The rows stand in blocks of three divided by rules.

toward its departure it nearly equalled the Sun itself, even though the Sun is given as 3462 times larger than the Earth.

[Margin: Cometa ut ut apparenter, quoad diametrum decrevit, reverà tamen mole crevit.] *Although the comet decreased in appearance as to its diameter, it nevertheless really grew in bulk.*

[Margin: Cometa circa exitum, Solis ferè magnitudinem æquavit, corpus ſi ſit ſphæricum.] *Toward its departure the comet nearly equalled the size of the Sun, if its body is spherical.*

[Margin: Quantò Sol Terrâ major exiſtat.] *By how much the Sun is larger than the Earth.*

No one, indeed, will be able to deny that everything — both the true diameter and what is attached to it — has been duly deduced from the comet's correctly found true distance and its observed apparent diameter, and so that on that foundation the comet was by no means smaller. Yet it still in no way follows from this that the solidity of that cometary body necessarily nearly equalled the solidity of the Sun. For the reason this phenomenon reached that immense quantity is that its body, according to the popular opinion, long ago proclaimed by the Peripatetics, is taken to be an entirely spherical body.

[Margin: Cometa corpus Solare reverà non æquavit.] *The comet did not in reality equal the body of the Sun.*

But whatever the case, those who hold this view aim very wide of the mark. For if we keep to sound reasons, and to our own observations and those of others, it will be evident that the bodies of comets are almost never wholly spherical, but only, as to the head, round and disc-shaped bodies, which nevertheless, by reason of their matter and the constitution of the body, have a certain thickness, spread out or extended like the spots and faculae of the Sun; so that these phenomena by no means consist of one solid body, or nucleus, compacted into a sphere, as indeed happens in the other planets, but consist of manifold and various opaque nuclei and bodies, loosely adhering to one another, with another matter, rarer and subtler, lying between them here and there and giving the rays of the Sun a free passage.

[Margin: Corpora Cometica minimè ſunt ſphærica; ſed diſciformia.] *The bodies of comets are by no means spherical, but disc-shaped.*

[Margin: Cometæ ex diverſis nucleis atq; corporibus conſtant.] *Comets consist of various nuclei and bodies.*

I am led wholly to this view both by compelling reasons and by some examples of comets, especially since I clearly detected this very thing with my own eyes in the recent comet. For from our observation made on December 27 with the help of the telescope, you have understood properly and without any doubt that I noticed in the cometary head itself various small bodies, like very tiny twinkling little stars; some of these were extremely small, barely striking the eyes, and some also a little larger, toward the east; in the west, however, a certain winding, rarer light; just as if it were a heap of very tiny small bodies

that could in no way be distinguished from one another: as is clear from the earlier drawing of that observation inserted on p. 327.

[Margin: Id quod exemplis comprobatur.] *This is confirmed by examples.*

And so it is clear that the body of the comet was in no way spherical, nor continuous and dense, consisting, that is, of a single body or nucleus; but rather that it was compounded of innumerable and most diverse bodies, some more opaque and some rarer, now closely cohering with one another, now with certain small spaces between them, as can be seen in the nebulous little stars and in the Milky Way. Hence it happens that when this cometary matter first begins to condense, the comet's head is then actually far larger in diameter than when it has already reached maturity, when the matter is more compact and the larger nuclei, as it were, associate with one another. The reason is that at this stage, because of the greater compression of the matter, its diameter cannot be so large. But when the head begins to thin out again and the small bodies to spread apart, then the matter, dispersing itself more and more, is once again extended more widely, and the head actually grows in diameter.

[Margin: Cometa qualè ſit corpus ex mente Autoris.] *What kind of body a comet is, in the author's view.*

[Margin: Quando Cometæ caput ſit maximum.] *When the head of a comet is largest.*

From this hypothesis it is proved that, since the small bodies of which the comet's head is composed continually change their position and shapes, and are little by little drawn further and further apart, that cometary head too must necessarily always shine more dully, more palely and with a gloomier colour, as it is in reality rarer, than when it is denser and packed with larger bodies. For the denser and more opaque it is, and the larger, more solid and more compressed its nuclei, the more clearly and strongly it reflects the light and rays of the Sun; and consequently comets then also appear more splendid and vivid than when the matter rarefies again and the nuclei separate and scatter.

[Margin: Quinam Cometæ ſint pallidi & obſcuri; rursùs quinam clariſſimi & ſplendidiſſimi.] *Which comets are pale and dim; and, in turn, which are the brightest and most splendid.*

Resting on this solid foundation, you will be able to explain and save successfully any of the phenomena of all comets: namely, where the various appearances of the tails and their various sizes come from; why very large comets, in respect of the head, sometimes appear dim and weak, and small ones, on the other hand, sometimes appear most splendid and brightest; how it happens that those nearer the Earth are smaller, while those farther away are in turn actually larger, although to the naked eye they are perceived as smaller; and very many other paradoxes of this kind. It is enough to have touched on them here in passing, and we reserve them for their own place and time, where we have proposed to treat all of them deliberately.

[Margin: Ex Autoris hypotheſi ſingula Cometar. phanomena integra ſunt.] [recte: phænomena] *On the author's hypothesis, each of the phenomena of comets is intact.*

These things that we have just said, namely that the small bodies and nuclei of comets wonderfully change their place, shape and size, and keep various distances among themselves, ought properly to be demonstrated by examples as well. But, to confess the truth, this cannot be done from our observations of the comet, however much I should wish it: for, hindered by other observations, I examined the comet with the telescope only twice, and by no means on each day, namely on December 27 and lastly on January 10, when the more solid nuclei were already quite extinguished. Nevertheless, reason suggests that on the 20th the comet consisted, if not of larger nuclei, at least of very many lying quite close to one another, with more solid matter scattered among them, since at that time it was most conspicuous; but afterwards, as the matter gradually rarefied and the nuclei were drawn apart and scattered, it necessarily appeared paler and dimmer.

[Margin: Corpuſcula ex quibus Caput Cometicum conſtat, perpetuò variantur, mutantur, locoq́; diverſimodè moventur.] *The small bodies of which the cometary head consists continually vary and change, and are moved from their place in diverse ways.*

That this happened in this way and not otherwise, we learn clearly from the most excellent observations that Father Cysat made of the comet with the telescope. For in the comet of the year 1618 he very distinctly and many times detected almost the same thing that we reached above about our own comet, only by conjecture; just as I also do not hesitate to affirm that the same happened in the other comets too, provided only that it had been duly observed by our predecessors. Indeed, I have no doubt at all that all those that will ever shine hereafter will demonstrate the same. For I would have you know that exactly the same thing occurred also in the comet observed by me in the year 1661. Since, God willing, I have proposed to describe it toward the end in a separate Book, I do not wish to say more about it on this occasion: you will see there that, as in this matter, so also to all the things that we have stated about comets in general, that comet added great strength.

[Margin: Id quod obſervationibus Cyſati evidenter probatur.] *This is plainly proved by Cysat's observations.*

But before we set out here Cysat's observation itself of the comet of the year 1618, with its genuine drawing, the observations of certain other most distinguished men on the same phenomenon must be given first, so that the matter may become all the clearer and more certain.

1. The excellent P. Crüger, once my teacher, always to be honoured with the best remembrance, says in his *Uranodromus Cometicus*, p. 2, that on December 1 he observed the comet truly large and fiery, with a tail of the same kind, about 9°; but on December 2 much smaller in size and duller in light and colour; on December 8 it showed a head that was by

no means ruddy, but much larger, and a tail extending to nearly 60°; on December 15 the tail appeared scarcely a little smaller, but the comet had decreased somewhat in its head. The same was observed in the following days, so that on the 29th it appeared greatly diminished.

[Margin: Crügeri obſervatio Cometæ anni 1618.] *Crüger's observation of the comet of 1618.*

2. The most experienced D. Isaacus Habrechtus [Isaac Habrecht], formerly physician to the Most Illustrious Count of Hanau [Hanaw], set out this same comet, observed at Strasbourg [Argentorati], in a certain small work, pp. 21 and 22, as follows: The phenomenon was round in its head and furnished with a tail; on November 21 it was detected at no mean size, and to a keen-sighted observer it appeared surrounded as if by a triple circle. The outermost flickered with a vibrating, twinkling and inconstant light, the middle one with a gentler light, to be sure, but a much more vivid one; but the inner one, the third of all, was the most splendid and brightest, so that it could be compared to nothing rather than to the splendour and brilliance of molten gold standing in the fiercest fire, etc. He adds that on the same day, in the morning, it gave out such splendour that it lit up the Earth with its light more than Venus at perigee, though its light was gradually decreasing. But the colour at first was to some extent ruddy, yet becoming whiter and rather pale; at the last it was very pale and very dim, like the Milky Way, etc.

[Margin: Cometam miram habuiſſe faciem Habrechtus teſtatur.] *Habrecht testifies that the comet had a wonderful appearance.*

3. But Cysat, more exquisitely than anyone so far, with a more accurate telescope noted that comet of the year 1618, as regards its head, colour and light as well as its manifold variation and the constitution of its body, and drew it graphically. All of this deserves to be well noted in this place, and even to be touched on somewhat more fully, since no one ever before carried out such extremely exquisite observations; and indeed, without any doubt, no small benefit flows from them to the world of learning in respect of this subject of comets, and the earlier obser-

[Margin: Cyſatus omnium primus Teleſcopio Cometam contemplatus eſt.] *Cysat was the first of all to view a comet with the telescope.*

vations are greatly illuminated and corroborated. But to return to Cysat's observation itself: On December 1 and 4 (he says) we examined the comet with diligent and prolonged inspection through the optical tube, and indeed through a pair of them, one about 6 feet long, the other 9 or 10. The star of the comet, or that more condensed light immersed in the comet's head, which we may from now on call the light, the nucleus or the core of the comet's head — this nucleus, I say, of the comet's luminous head appeared round in shape, with a continuous and compacted light, although by no means bright or brilliant. Its diameter was indeed larger than that of any fixed star of the first magnitude, if that star too is viewed through the tube, but much smaller than the diameter

of Jupiter appeared on the same days, so that at most it could have taken up two thirds of the Jovian diameter.

[Margin: Exquiſitiſsima Cometæ 1618 obſervatio à Cyſato habita.] *A most exquisite observation of the comet of 1618, made by Cysat.*

Further, this nucleus of the comet's luminous head, of a dense but leaden and dark light, had all around it a rarer and paler light, in a border [limbus] nearly twice as broad as the diameter of the nucleus itself. The phenomenon is very like the one the Moon presents when it shines through little clouds or vapours, or thin clouds, with a pale border poured around it, itself pale as well; nor is it very unlike that nebulous star which is seen with the tube above the Girdle of Andromeda, toward the north, except that this star is far dimmer than the comet. And although a certain third radiance [jubar], of far more diluted and dimmer light, also surrounded that nebulous corona which encircled the nucleus, yet because that light was not denser than the light of the comet, and indeed seemed to be the comet itself flowing out, we were unwilling to count it as part of the comet's head. The comet's head therefore consisted of a dense core or nucleus and a crowning border, broader indeed, but of much rarer light: and the diameter of the nucleus was about 2′, the breadth of the border 3′, the whole diameter of the head about 8′.

[Margin: Caput iſtius Cometæ denſo conſtabat nucleo.] *The head of this comet consisted of a dense nucleus.*

December 8. Not only the whole head of the comet (that is, the nucleus together with the radiance poured around it), but also the nucleus on its own appeared twice as large as Arcturus in diameter, 3′ or 4′ (whereas on the first day it had been far smaller); and it was no longer round, but split into three or four globules of irregular shape, cohering with one another, such as the companions of Saturn usually appear.

[Margin: Nucleus Cometæ in plures abiit die 8 Decembr.] *The comet's nucleus broke up into several [parts] on December 8.*

December 17. In place of that nucleus, lately compacted, there now appeared some extremely small little stars, with a very dull light poured around and among them, glittering forth as if out of a mist or a white cloud; and this was seen much more clearly and distinctly on the following day, the 18th.

December 20. The core or nucleus, which on the first day had appeared as an almost solid and round light, appeared more plainly dissolved into many little stars, so that it was now a cluster of a great many very small little stars, of which three were seen more constantly and distinctly than the rest, and the largest of them was like a star of about the 5th magnitude. Besides this, outside that cluster of little stars, a little star also shone out in the radiance poured around it, which at first was thought to belong to the rest of the cluster; but after an hour and a half it proved to be one of the fixed stars, when it had already moved 6′ away outside the radiance. This little star, too, was far smaller than the smallest companion of Jupiter. Finally, the diameter of this nucleus, or now of the globe of stars, was 5′ or 6′, certainly notably larger than on December 1.

[Margin: Caput Cometæ apparuit, ac ſi esſet multarum Stellularum congeries.] *The comet's head appeared as if it were a cluster of many little stars.*

December 24. Both the nucleus, or globe and cluster of little stars, and the radiance itself poured around it occupied a far larger space than before, but with a much thinner and rarer light. Of the three little stars lately distinguished, now only one con-

[Margin: Caput indies crevit quoad diſcum, quoad lumen verò & ſplendorem decrevit.] *The head grew day by day in its disc, but decreased in light and splendour.*

stantly appeared; the others were indeed very many, but could not be counted distinctly, because, although they were seen twinkling surely and often, yet they did not meet the eye continuously and steadily all together, but intermittently, one after another, as if by leaps, in just the way that the smallest fixed stars are usually seen even with the naked eye in a very clear sky. Finally, the individual [little stars] were also today far more scattered from one another than on the previous days, so that the diameter of the nucleus was at least 6′, the breadth of the surrounding border 5′, and the whole diameter of the head about 16′. And this was the last day on which it could be observed through the tube. What has been said is represented, as far as it can be, in the diagrams below.

Diagram. An engraved figure of four round comet heads, two above and two below, each a disc fringed with fine radiating strokes. Upper left: a small round nucleus ringed by a dark dotted circle. Upper right: a nucleus broken into a few dark irregular patches inside a lighter round area. Lower left: a larger, irregular light area strewn with small star-shaped points. Lower right: a still larger light area strewn with more star-shaped points. Each head is dated by an engraved label above it; the engraver's note stands below the lower right head. No letters stand on the heads themselves.

- Above the upper left head: Decembr. 1. — December 1
- Above the upper right head: Decemb. 8. — December 8
- Above the lower left head: Decemb 17.18.20. — December 17, 18, 20
- Above the lower right head: Decembr. 24. — December 24
- Below the lower right head: Autor ſculpsit. — The author engraved [it].

[Margin: Genuina facies Cometæ anni 1618.] *The true appearance of the comet of 1618.*

It should further be noted that from the first day of December to the 24th the comet's head actually always grew in a certain proportion as regards its extent, whether you look at the nucleus or at the radiance poured around it; but as regards the density and clarity of its light it always became diminished, and more diluted and rarer. Thus through the tube the comet's head appeared smallest on the first day and largest on December 24. Exactly the opposite happened to unaided sight: to it the comet's head appeared largest on December 1 and far smaller on the 24th, namely because of the dispersal of the little stars and the diminution of the light.

[Margin: Idem deprehendit Scheinerus Æniponti.] *Scheiner found the same at Innsbruck.*

Lastly, the author adds that he observed all these things, together with other learned men, with the greatest diligence and good faith, so that he often spent half an hour, and sometimes a whole [hour], entirely without a break, in inspecting and examining this phenomenon. Likewise Christophorus Scheinerus [Christoph Scheiner], most practised in observations, observed this comet at Innsbruck [Æniponti] with an altogether similar appearance: on this you may read, if you please, Book IV, Part II, Chapter XIII, p. 612 of the *Rosa Ursina*.

[Margin: In Com. 1618. Capitis nuclei in plures disfecti fuerunt, teſte Wendelino.] *In the comet of 1618 the nuclei of the head were cut apart into several, as Wendelen witnesses.*

Moreover, Govaert Wendelen likewise attests this very thing — namely that the comet's head was composed of most diverse small bodies exercising their own particular motion, which afterwards were resolved and, as it were, cut apart into very many other smaller ones — in his *Teratologia Cometica* Luminarcani, p. 21: For the head of the comet itself, he says, when I first explored it with the telescope on November 29, I found to be like three or four bright coals of a huge hearth, kindled with a strong fire. I saw, I say, the comet as if a triple globe: and indeed I noticed that these three coals changed their position somewhat in my presence, as if there were someone stirring the hearth; and on the following days more coals were seen by me, just as our coals, once kindled, leap apart into several pieces.

From these observations, and from those of all the others who watched that comet at that time, we clearly gather that the comet's head and tail appeared to the naked eye to decrease from day to day, both in size and in light; and that about the time of its last appearance it became so thin and faint, like some nebulous star or a small part of the Milky Way: just as was noticed in that comet which shone forth in the reign of Attalus, of which Seneca [says]: that, being moderate at the start, it suddenly raised itself up and spread out, and equalled the Galaxy.

[Margin: Corpus Cometicum ex multis componitur corporibus.] *The body of a comet is composed of many bodies.*

With more accurate tubes, however, they found, first, that the comet of 1618 was by no means compacted and fused together out of one solid body, still less a spherical one, but out of many most diverse bodies and irregular nuclei, which continually changed their size and position; so that those nuclei constantly exercised a particular motion of their own, as much of alteration as of place, from which afterwards a great change in its appearance arose.

Second: they noticed that the comet appeared very bright at the beginning, but afterwards successively paler and darker.

[Margin: Cometa 1618 initiò ex uno ſolidiori conſtabat nucleo.] *The comet of 1618 at first consisted of one more solid nucleus.*

Third: that the comet at first consisted of a single, more solid nucleus, which a more diluted rim surrounded. That on December 8 this nucleus was divided

into three [parts] of irregular shape; which then, namely on the 17th and 18th, degenerated into various extremely small, as it were, little stars; and on the 24th, dissolving themselves into a great many far smaller ones.

[Margin: Quâ ratione caput Cometæ illius creverit.] *In what way the head of that comet grew.*

Fourth: that the middle or nucleus of the comet, together with the very radiance poured around it, always grew as regards the size of its disc, but as regards its light and clarity, and its density, always decreased: so that on December 1, about its beginning, the nucleus was only 2′ in diameter; on the 8th, 3′ or 4′; on the 20th, 5′ or 6′; and on the 24th, at least 6′. But the whole diameter of the head appeared, not only with the help of the tubes but also of instruments, [as] 8′ on December 1; 10′ on December 8; 13′ on the 17th; 14′ on the 20th; and 16′ on December 24.

[Margin: Cometa 1618 continuò à terrâ magis magisq; elongatus eſt.] *The comet of 1618 continually moved farther and farther away from the Earth.*

Moreover, according to each and every observer, it is most certain that the comet was nearer the Earth about the time of its first rising, and afterwards withdrew farther from the Earth day by day. But I think I have now said enough both about the observations themselves of the comet of 1618 and about the points most worth noting in them. Let us now also see whether all those appearances, and whatever phenomena commonly occur in comets, can be saved on the supposition that comets consist of extremely small bodies of diverse kinds.

[Margin: Philoſopho incumbit ſententiam ſuam in ſenſuum evidentiam ſempe referre.] *It is the philosopher's duty always to refer his opinion to the evidence of the senses.*

For it befits a philosopher above all to refer his doctrines always to the evidence of the senses: just as Aristotle himself, the coryphaeus of philosophers [Philoſophorum Coriphæus], never inculcates anything more than that, in explaining the nature of each thing, the appearances of things must be saved. Likewise, in the *Univers. Philosoph.*, chapter VIII, pages 117 and 174, Franciscus Baco de Verulamio [Francis Bacon], a man indeed of the most profound learning, urges *that the decrees of philosophy should be such as are entirely explicable upon the phenomena of astronomy*.

[Margin: Ex Autoris hypotheſi omnes apparentiæ egregiè ſalvantur.] *On the author's hypothesis all the appearances are excellently saved.*

Far be it from us too, therefore, to lay down anything in this most subtle business of comets that would seem to conflict outright with the phenomena. For my part, unless my own [ideas] please me too much, I think that all these matters, whatever pertains to comets, can hardly be better explained and derived from any other hypothesis: as will soon become clearly evident from the questions to be raised.

[Margin: Cur Com. 1618 principiò ſplendidior extiterit ?] *Why was the comet of 1618 more splendid at the beginning?*

1. So it is asked: from what cause did the comet of the year 1618 appear much clearer and brighter at the beginning than at the end? Answer: because it consisted of one single nucleus or body. Since this nucleus was at that time of remarkable size and of rare solidity, it consequently reflected the rays of the Sun to us more strongly and more vividly (for I hold that comets enjoy no light of their own, but only borrowed light) than if it had been dissolved into smaller and rarer nuclei, with little spaces lying abundantly between them and very thin matter scattered among them. For a more solid body is far better suited to reflecting rays than a rarer one, as optics teaches.

[Margin: Cur idem Cometa die 8 Decemb. pallidior fuerit ?] *Why was the same comet paler on December 8?*

2. It is asked why on December 8 it was already somewhat paler and darker. Answer: because at that time it had already split into three smaller nuclei. And for that reason on the 17th it was seen still duller, namely because it had been dispersed into many more nuclei, or little stars; indeed, on the 24th it was found extremely pale and extremely dark, because the comet had been reduced into a great many extremely small, rarer corpuscles and more diluted matter.

[Margin: Cometæ quò paucioribus & ſolidioribꝰ conſtant nucleis, eò lucidiores ſunt ?] *The fewer and more solid the nuclei comets consist of, the brighter they are?*

From this, therefore, we rightly conclude that the more splendid and brilliant comets are, the fewer but larger and more compact are the nuclei they consist of; whereas the paler and darker they appear, the more numerous, but smaller and rarer, are the nuclei and corpuscles they are composed of, standing farther apart from one another, with more diluted matter mixed among them.

[Margin: Cometa 1652, cur ſubobſcuri pallidiq́; fuerit coloris ?] *The comet of 1652: why was it of a darkish and pale colour?*

For this reason the comet of the year 1652 never appeared as splendid and bright as that other one of the year 1618, as it was seen on December 1: because this one [of 1618] consisted of larger nuclei — indeed, around its first appearance, understand, of one single nucleus — while that one [of 1652] consisted only of many extremely small corpuscles, and these, moreover, quite rare, with very abundant, more diluted matter lying between them.

[Margin: Ex lumine & coloribus motus nucleorum, ex quibus caput aliàs conſtat haud malè cognoſcitur.] *From the light and the colours, the motion of the nuclei of which the head in any case consists is recognised quite well.*

From this, too, it is not badly inferred (in my opinion at least) that our comet was continually of a pale colour, gradually fading: namely because its nuclei continually moved farther and farther away from one another, and were separated by a certain very slow proper motion of those nuclei. On the contrary, since in the comet of the year 1618 the nuclei changed very rapidly in position, shape and number, and so displayed a very swift motion, that sudden change of

colours and light arose from this. For whatever comet, according to this given hypothesis, suddenly varies its colours and light, its nuclei, of which the head is composed, are endowed with a very swift motion. Conversely, those comets that change their colours gradually consist of such bodies as enjoy a very slow motion; and the comet of the year 1652 is rightly counted among their number. This is clear from Wendelen's observation, made on December 21, and from ours, made on the 27th of the same month: namely, that the motion of the nuclei relative to one another was very slow, since they varied their position and shape very slowly.

[Margin: Quo compactior materia, eò lucidiores ſunt Cometæ.] *The more compact the matter, the brighter comets are.*

It follows, next, that there can also be some comets which, though their head is smaller, are nevertheless most splendid and most bright; and conversely others, with a larger body indeed, but very pale and very dark. The smaller ones [are such] when they have grown together out of one, namely, large and dense nucleus; but the larger ones, when they consist of many nuclei, very small and rather rare corpuscles. But if some comet, large in its head and most splendid, should shine forth, like the one before the war against the Achaeans, which had risen: I fully believe that such a [comet] consisted of [nuclei] at once large and at once extremely solid, glued closely to one another as it were, and of extremely dense matter; in accordance with the axiom already inculcated so often: the more compact the matter that light has obtained, or that which receives and reflects light, the more brilliant it will be.

[Margin: Quare obſcuriores & debiliores Cometæ ſint frequentiores ?] *Why are darker and fainter comets more frequent?*

Very bright and very large comets of this kind, however, occur quite rarely; those of a duller colour occur more frequently. The cause is this: the matter of comets is very rarely condensed so far that such very large and very solid nuclei can be generated, much less that it should compose one single body; for the most part that matter is dissolved before it can reach so great a maturity and solidity.

[Margin: Cur aliusCometarum alio ſit diuturnior ?] *Why is one comet longer-lasting than another?*

3. It is asked why some comets are longer-lasting than others and appear for a longer time, even if you leave aside the heliacal setting of comets. Answer: in our view, those will be longer-lasting which consist of more solid and rather large nuclei and of denser and more tenacious matter, and whose bodies, moreover, possess a very slow motion of congregation and of dissipation; above all those that are reduced to one solid body and display a very slow motion along their trajectory, withdrawing from the Earth only little by little. The remaining comets, by contrast, consist of more diluted matter and of very few and very small corpuscles that never come together into one solid nucleus, and have besides a very swift motion along their trajectory and of segregation. Those, I say, last for a

short span of time and escape the sight of the eyes very quickly, inasmuch as their matter is easily dissolved and dissipated and reflects the light of the Sun only with difficulty, so that they cannot be seen for long.

[Margin: AnCometarum diameter vera diſcedendo à Terrâ perpetuò minuatur ?] *Does the true diameter of comets continually decrease as they withdraw from the Earth?*

4. It is asked whether the true diameter of comets, as they withdraw from the Earth day by day and are carried more and more into the higher aether, also diminishes from day to day, as is indeed noted, accurately and with the naked eye, in their apparent diameter; or whether instead the true diameter remains always similar to itself and the same in every situation, lower as well as higher. We answer that in certain comets the true diameter continually grows, even as they withdraw more and more from the Earth, and very rarely shows its quantity always the same, although to the naked eye the contrary appears. For when comets have already reached a mature age (which happens to most of them in places nearer the Earth) and are gradually removed farther from the Earth, then, I say, the nuclei begin little by little to separate from one another, and the matter to dissolve and become rarefied, and so to be dilated more and more. From this the true diameter, and also the apparent one, is necessarily found always to grow, if anyone examines it with instruments.

[Margin: Quanta Cometæ 1618 vera diameter diverſis diebus extiterit.] *How great the true diameter of the comet of 1618 was on various days.*

This is clearly proved by the comet of the year 1618. The apparent diameter of its whole disc was estimated on December 1 at only 8′; on December 9 it had already reached a magnitude of 10′; on the 17th, 13′; on the 20th, 14′; and on the 24th, 16 minutes. And indeed this is evident not only from the observed apparent diameter but also from the calculation itself. For if, given the observed diameter and the distance for each day, you compute its true diameter, it will become known that this very diameter actually became larger day by day. But to embrace everything briefly, I shall at once append the sum of the calculation, deduced from Cysat's distances on p. 52 for the same comet, and from the apparent diameter observed with the greatest diligence by the author himself: namely, how great the true diameter was on various days, in German miles.

[Margin: Cometæ 1618 apparens & vera diameter in dies crevit.] *The apparent and the true diameter of the comet of 1618 grew day by day.*

Month, day	Distance from the Earth, semidiameters of the Earth	Apparent diameter, minutes	True diameter from the calculation, German miles
December 1	72	8	144
9	96	10	240
17	132	13	430
20	154	14	540

Month, day	Distance from the Earth, semidiameters of the Earth	Apparent diameter, minutes	True diameter from the calculation, German miles
29	252	16	1010

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From this it is clear, the calculation having been set up correctly in this way, that the diameter of the comet grew continually. Believe me, this comes about from no other cause than that the nuclei were gradually segregated more and more, and the matter was dissipated and extended into a larger disc, as it were.

[Margin: Quando Cometa quotidie lucidior ſit, indicium eſt, nondum ad maturitatem eum pervenisſe.] *When a comet becomes brighter every day, it is a sign that it has not yet reached maturity.*

But if, in some comet withdrawing from the Earth every day, both the true and the apparent diameter should increase and grow at the same time, and it should likewise appear continually brighter, then I consider that we must conclude that the diameter becomes larger and greater not by reason of the dilation and dissipation of the matter or of the bodies, but from the confluence of several opaque bodies, with new matter coming in on top; and that the head of the comet is thus still engaged, as it were, in accretion and augmentation, and has not yet reached maturity.

[Margin: Cometa 1652, quò magis à terrâ elongat[9], eò magis etiam diameter apparens attenuata eſt.] *The comet of 1652: the farther it was removed from the Earth, the more its apparent diameter too was diminished.*

But, you will say, why was something almost different observed in the comet of the year 1652? For although it became higher and darker day by day, its diameter nevertheless decreased continually and notably, both with the help of instruments and tubes and to the unaided eyes; and this seems to conflict entirely with what was said above. For the matter ought to have been dilated and the corpuscles segregated further, since, as we have said, it became ever more diluted and paler.

[Margin: Reverà diameter ejus in dies crevit.] *In reality its diameter grew day by day.*

Certainly this objection, just as it is not a trifling one, so it deserves to be discussed more fully, as one that seems to contribute a great deal to this business of comets. But it must indeed be understood that the diameter does not always really decrease, even if it seems so in appearance; sometimes the contrary happens. This is quite easy to demonstrate by calculation: if the true diameter of the comet of the year 1652 is properly derived for each day from the

541 on the page the table stands at the head of the page in the left part of the measure, with the first eight lines of the following text set beside it on the right. Its heads read *Menſ.Dies.*, *Diſtant. à terrâ Semid.T.*, *Appar. diamet. Minut.* and *Vera diameter ex calculo Mill.germ.*; the month is printed once, in the first row. A rule divides the first three rows from the last two. The last row gives the 29th, where the text on the preceding page gives the 24th for the same 16 minutes.

genuine distances and the apparent diameter, it will become apparent that this is how the matter stands. Since this has already been done above, on p. 337, and also set out in order in a small table, we can dispense with that labour. If, then, you consult that table properly, you will find that for the first four days the comet remained, as it were, in the same state, but that in the days immediately following it grew continually and in a wonderful manner: just as day by day it grew in darkness and faintness, so it grew in size as well.

[Margin: Cometæ quantò obſcuriores ſunt, tantò illorum diameter major eſt.] *The darker comets are, the greater their diameter.*

So it is nonetheless most true that the more comets fall off in brightness, the more their true diameter actually increases, although as to the apparent [diameter] they continually decrease: which was what had to be investigated.

That in some comets, as in the year 1618, the true and the visible diameter were increased together, while in certain others only the true one was, the visible one decreasing, as in the year 1652, comes about from this: in the former the distance from the Earth changed and increased only very little, while on the other hand the motion of the matter and of the bodies of which the cometary head consisted was extremely agitated, and the proportion of the motion of the nuclei was greater than that of the distances, so that the matter and the nuclei could then easily be dissolved and dissipated. In the latter, however, as in ours, it happened that the distances from the Earth made great and remarkable advances every day.

[Margin: Cur in quibusdam Cometis vera & viſa diameter ſimul creſcat ?] *Why do the true and the visible diameter grow together in certain comets?*

Therefore, even if the apparent diameter, owing to the immense elongation it has acquired, should appear smaller day by day, the true diameter must nevertheless really grow. For this reason, in those com- ets in which the distance from the Earth varies only gradually and slowly, as was observed in the comet of the year 1618, the true diameter always grows together with the apparent one. In the rest, however, where the distance from the Earth changes and increases very swiftly, only the true diameter expands and really increases.

And so it is plain to anyone that, on our view, these phenomena can be saved excellently. But how the Peripatetics could do this very thing I scarcely see: namely, that comets, mostly toward their end, must grow in respect of their true diameter. For they hold that comets are gradually consumed by fire, and hence that in their view the bodies of comets continually decrease, right up to their destruction. This runs against clear observations, which plainly prove the contrary: that comets, at almost every time, mostly around their end, increase in respect of the disc, even though they become more and more obscure, and are so thinned out that they seem to be entirely extinguished.

[Margin: Ex ſententiâ Autoris quævis phænomena feliciter explicantur, & demonſtrantur.] *On the Author's view any phenomena whatever are happily explained and demonstrated.*

[Margin: Peripateticis Cometarum diametri perpetuò diminuuntur, contra manifeſtisſimas obſervationes.] *For the Peripatetics the diameters of comets continually diminish, contrary to the most manifest observations.*

But, you will say, what if we hold that comets keep and preserve the same true diameter all the while, until the matter in them is either consumed by internal causes or vanishes altogether? Shall we not be able to save those appearances just as well? Certainly not. So that you may grasp this the better, come now, let us consider our comet of the year 1652 distinctly. For, once this were granted, it would have presented itself to us far otherwise, and indeed much smaller as to its apparent [diameter] (to say nothing of the rest); and, according to the proportion of its distances from the Earth as it held from day to day, the said apparent diameter would have had to decrease quite otherwise than the observations themselves showed it.

For from what precedes you have, I think, understood well how large the apparent diameter was from the observations: namely, on December 20, 30′; on the 26th, 24′; on January 1, 10′; on the 7th, 5′. Suppose these are taken with the corresponding distances, while the true diameter of 825 miles that the comet had on December 20 is kept the same at all times, and suppose that from these data we seek the apparent [diameter] in this way. We shall find, as we were just saying, that it ought to have appeared far more compressed than was in fact found from the observation itself: so that on the 26th it would have been only 17′ 28″, on January 1 only 2′ 2″, on January 7 24″, and on January 10 scarcely 12″. But who does not see how great a difference there now is between this apparent diameter deduced from the calculation and the one we observed with skill!

[Margin: Apparens diameter Cometæ 1652,quá ratione decreverit.] *How the apparent diameter of the comet of 1652 decreased.*

[Margin: Quanta extitisſet diameter apparens,ſi vera ſemper eadem permanſisſet.] *How large the apparent diameter would have been, if the true one had always remained the same.*

But you will understand all this still more clearly from the table set beside this text. In it, for every day of the apparition, we have computed both the comet's corresponding distance from the Earth and the observed apparent diameter, and also the apparent diameter derived from calculation, keeping, as we indicated, always the same true diameter, namely 825 miles.

Year 1652, days	Distance of the comet from the Earth (semidiameters of the Earth)	Apparent diameter observed	Apparent diameter from calculation, always keeping the same true diameter
		Mi.Se	*Min. Sec.*
20	110	30′ 0″	30′ 0″
21	110	30′ 0″	30′ 0″
22	111	29′ 0″	29′ 44″
23	114	28′ 0″	28′ 58″
24	124	26′ 0″	26′ 36″

Year 1652, days	Distance of the comet from the Earth (semidiameters of the Earth)	Apparent diameter observed	Apparent diameter from calculation, always keeping the same true diameter
25	146	25′ 0″	22′ 36″
26	189	24′ 0″	17′ 28″
27	265	22′ 0″	12′ 28″
28	384	20′ 0″	8′ 36″
29	562	18′ 0″	5′ 52″
30	817	16′ 0″	4′ 4″
31	1166	13′ 0″	2′ 50″
An.53. 1	1630	10′ 0″	2′ 2″
2	2233	8′ 0″	1′ 28″
3	3000	7′ 0″	1′ 6″
4	3957	6′ 30″	0′ 50″
5	5134	6′ 0″	0′ 38″
6	6563	5′ 30″	0′ 30″
7	8277	5′ 0″	0′ 24″
8	10311	4′ 40″	0′ 20″
9	12704	4′ 20″	0′ 16″
10	15495	4′ 0″	0′ 12″
11	18795	3′ 45″	0′ 10″
12	22509	3′ 30″	0′ 8″

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You see, then, my Reader, that on these suppositions the apparent diameter would have varied by many minutes, so that, with the comet's true size always taken as the same, the apparent [diameter] would have been reduced to very few seconds within the space of only a few days; whereas it is established from observation that at that same time it was still of many minutes. It follows, therefore, that if things stood so, the comet would have withdrawn itself from our sight much sooner. For when the comet, with its apparent diameter still 4′ or 5′, scarcely met the eyes even of those endowed beyond others with an exceptional keenness of sight, what, I ask, would have happened if it had had only 10″ or 20″ in diameter? Would it not already have vanished entirely on December 30? Indeed, if you weigh the matter rightly and bring it to calculation, you will readily admit that it could scarcely have been seen on the 29th: for at that time it was already so thinned that it was only 6′, as we have found from the preceding table. Yet nothing is truer than that the comet was seen for a long time indeed, by almost everyone. What of the fact that [it

[542] on the page this table stands at the left of the measure, with the last 24 lines of the text set in a narrow measure to its right; it has no caption. The Latin heads are "Anno 1652 Dies"; "Diſtant. Cometæ à Terrâ S. T."; "Diam. appar. obſervata."; "Diam.appar. ex calc. ſerv. ſemper eâdem diamet. verâ." Columns 3 and 4 each print the minutes and the seconds as two figures under the sub-heads given in the second row, with no rule between them. Column 1 prints the day of the month only; the days run from December 20, 1652, and "An.53." (the year 1653) is set before January 1. A rule crosses the table after every third row.

was seen] still on January 7 and 8? Therefore this comet in no way kept the same true size of its disc throughout. Nor do I think that any others ever either appeared or can appear (if, that is, they recede continually more and more from the Earth, become more obscure and paler, and tend toward their destruction) that can always keep their true diameter equal to itself.

[Margin: Si diſcus in dies decreviſſet multo citiùs diſparere viſus fuiſſet Cometa anni 1652.] *If the disc had decreased from day to day, the comet of the year 1652 would have seemed to disappear much sooner.*

[Margin: Nec Cometa 1652 nec unquam alios apparuiſſe eandem continuò diametrum veram ab initio ad finem conſervantes.] *Neither the comet of 1652 nor any others ever appeared keeping the same true diameter continuously from beginning to end.*

So much less, then, did this same comet decrease in respect of its disc and its true diameter (and I would have the same said of almost all the others too). For if the disc had really been diminished from day to day, it would have vanished much sooner still, so much so that it would barely, if at all, have appeared for 5 or 6 days, as the calculation plainly shows and as everyone will find from the table set beside this.

In this table the apparent diameter has been computed for several days, given, that is, the corresponding distance and the true diameter, decreasing daily by 100 miles. From these data, however, the apparent [diameter] came out far smaller than it really was by observation. For already on December 25 it would have been seen no larger than 8′ and no brighter than it actually was on January 2; on December 26 the comet's diameter would have been reduced to 4′, the size at which it still appeared to us on January 10; and on the 27th it would have been so thinned that it could in no way have been perceived by the eyes, since it would have had only 1′ 30″ in diameter. And so within the space of 24 hours it would have become entirely imperceptible.

[Margin: Si diameter Cometæ 1652 ſingulis diebus 100 mill. decreviſſet, die Decemb. jam evanuiſſet.] *If the diameter of the comet of 1652 had decreased by 100 miles each day, it would already have vanished on December*[543].

Year 1652, December	Distance of the comet from the Earth (semidiameters of the Earth)	True diameter in German miles	Hence the apparent diameter
			Min. Sec.
20	100	825	30′ 0″
21	100¾	700	25′ 16″
22	111¼	600	21′ 34″
23	114	500	17′ 32″
24	124	400	12′ 54″
25	146	300	8′ 14″
26	189	200	4′ 14″
27	265	100	1′ 30″

[543]the side-note prints no day of the month here

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But the matter will become clearer still if we suppose that the comet decreased, as to its true diameter, in exactly the same ratio in which it in fact grew. Then it would certainly have seemed to us to perish far sooner.

Year 1652, month, day	Distance of the comet from the Earth (semidiameters of the Earth)	True diameter of the comet in miles	Apparent diameter of the comet
			Min. Sec.
Dec. 21	110	825	30′ 0″
22	111	804	28′ 50″
23	114	800	24′ 4″
24	124	794	21′ 44″
25	146	686	14′ 30″
26	189	466	7′ 0″
27	265	48	0′ 30″

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Suppose, as we said, that the comet really decreased in the proportion that the table set beside this reports, so that on the 27th its diameter would have been only 48 miles; then the apparent diameter, the calculation having been duly carried out, on the 26th of Decem- ber would have been 7′, and on the 27th only 30″. Hence on the 26th the comet would indeed have met the eyes clearly, but on the 27th it would have been entirely extinguished in a moment, as it were, like a flash of lightning. From this it is at the same time easy to show how suddenly and unexpectedly comets can sometimes be born and pass away, if they grow or decrease in such a manner, as will be said more fully in the following Book, on the generation and corruption of comets.

[Margin: Poſſunt nonnunquam ſubitò Cometæ in conſpectum prodire, ac iterum viſui ſe ſe ſubducere.] *Comets can sometimes come suddenly into view and withdraw themselves from sight again.*

5. Further, granted this hypothesis of ours, we also readily perceive how the origin and destruction of comets come about, and how they acquire a perfect consistency. For when a certain rarer matter, and other, denser corpuscles, are gathered together and condensed, and form as it were

544 on the page this table stands at the right of the measure, beside the eight short lines of text that begin "In this table"; it has no caption. The Latin heads are "An.1652 Decemb."; "Diſtantia Com.àterrâ. S. T."; "Diam. vera inMill. German."; "Diam. ergo Apparens Min. Sec.". Column 4 prints the minutes and the seconds as two figures, with no rule between them. A rule crosses the table after the fourth row. In column 2 the distances for the 20th, 21st and 22nd are printed 100, 100¾ and 111¼, where the table on the preceding page and the table below give 110, 110 and 111.

545 on the page this table stands at the left of the measure, beside the six short lines of text that begin "Suppose, as we said"; it has no caption. The Latin heads are "An. 1652 Menſ. D."; "Diſt.Com. à ter.S.T."; "Diamet. vera Com. in mill."; "Diam.app.Com. Min. Sec.". Column 4 prints the minutes and the seconds as two figures, with no rule between them. A rule crosses the table after the fourth row.

a heap of nuclei, then the comet is, so to speak, first born, and offers itself to be seen by us, unless too great a distance from the Earth prevents it. But when that matter in turn — partly the transparent cometary [matter], partly the nuclei, as the denser parts — is separated, dissolved and thinned out, then the comet vanishes. To put it more briefly still: a comet arises from the condensation and accretion of a certain matter, and also from the gathering and packing together of corpuscles; conversely, it is extinguished by the dispersal, dissolution and thinning of the matters and of the nuclei.

[Margin: Quâ ratione Cometæ oriantur ac occidant.] *In what manner comets arise and perish.*

In the same way the sunspots too take their increase and decrease in the atmosphere of the Sun, and by them this business of comets is elucidated best of all. For they likewise are generated solely from the flowing together or flowing apart of a certain denser matter, and from the concurrence, coagulation and condensation of several opaque bodies; and in turn they perish by thinning, dispersal and disjunction. For when some spot is to arise physically, first a matter is seen in that same place like a very faint shadow, but sometimes very large, and spread and diffused very widely. Afterwards it gradually gathers and coalesces and is pressed more tightly together, until from that same packed matter very diverse nuclei, not rarely, are generated, gradually growing in bulk; and from their flowing together and concurrence, with other new matter also coming on top, spots that are huge and of astonishing size take their origin. But if the said nuclei and those minute corpuscles, together with the thinner matter adhering to them, are suddenly separated again and dissolved, the spot of the Sun readily perishes without warning, and no notable one is produced. It has also mostly been noticed that, when the larger spots tend toward their physical destruction, their larger nuclei are resolved and dispersed into several very small ones, which afterwards gradually separate and move away from one another, until the matter itself is reduced, as it were, to nothing by thinning. But we shall treat of these more fully later, in their proper place. For these sunspots can certainly be of no small use in thoroughly examining the matter of comets.

[Margin: Cometæ cum maculis Solaribus optimè conveniunt.] *Comets agree very well with the sunspots.*

[Margin: Quomodo Maculæ Solares generentur, ac disſolvantur.] *How sunspots are generated and dissolved.*

6. It is asked whether the disc of all comets is at all times perfectly round. The answer is no. For since comets, on our view, consist of many very diverse, indeed sometimes innumerable, corpuscles and nuclei, it can by no means happen that the joining and gathering of the bodies, and likewise their accretion, which comes about in such diverse ways and at diverse times, should be so regular that, entirely to the absolute figure of a circle, with always the same propor-

[Margin: An Cometarum diſcus ſemper ſit rotundus ?] *Whether the disc of comets is always round.*

tion kept, it could approach. Rather, what then mostly happens is that more matter accrues here and there, and from this various prominences, protuberances, concavities and very irregular windings come to exist in that cometary body. Such [features] without any doubt really existed in these two comets of the years 1618 and 1652 as well, so that for this reason they were by no means perfectly round. That they nevertheless appeared almost round came about from their immense distance from the Earth: in such a position even entirely irregular bodies present an absolute roundness, as optics demonstrates.

7. It is asked further whether those nuclei, or corpuscles, or those little stars, of which the cometary body is composed, are of perfect roundness. Again the answer is no. For in my opinion at least, none at all of the planets, which draw their light from the Sun, is or can be of an absolutely round body, but [each is] of a rough and uneven one: otherwise it would by no means reflect a universal light to us, as has been clearly demonstrated in optics and in our *Selenographia*, Chap. VI. Just so, those nuclei too, which make up the head of the comet, are irregular bodies having their own roughnesses, concavities and protuberances; and if they lacked these, no universal reflected light of the Sun would be noticed from them either.

[Margin: Nec nuclei, ex quibus caput Cometicum conſtat perfectæ ſunt rotunditatis.] *Nor are the nuclei of which the cometary head consists of perfect roundness.*

Although I readily grant that this very thing cannot so easily be demonstrated by us in the comet of the year 1652, because those nuclei were so slender that they almost eluded sight, it is nevertheless to be plainly established from Cysat's comet, which shone in the year 1618, that it had nuclei of irregular figure: for on December 8 he accurately found it [to consist] of three irregular nuclei cohering with one another. Yet I do not altogether deny that there can sometimes also be corpuscles that are round to some extent, indeed some rounder than others, but not all: as usually happens in the sunspots, in which the nuclei are mostly irregular, though some surpass others in roundness, and some come closer than others to a more absolute roundness — never, however, or only very rarely, to an entirely perfect spherical [roundness], but only to such as pepper and corpuscles of this kind display. Although these have very many concavities and little cavities, yet, seen from a distance, they can in no way be distinguished; rather, you would judge them to be perfectly round bodies.

[Margin: Cometa anni 1618 nucleos habuit irregulares.] *The comet of the year 1618 had irregular nuclei.*

We have therefore shown abundantly, kind Reader, how matters stood altogether with the heads of the comets of the year 1618 as well as of the year 1652; and that we are entirely of the opinion that the same happens with all other genuine comets too (excepting apparitions and meteors of the air, which are sometimes taken for comets, but wrongly): namely, that they are composed of

very diverse irregular corpuscles, which in their time are gathered together and condensed, and in turn are separated, dissolved and dispersed, as we discussed more broadly above. This can indeed be demonstrated in certain other comets as well. For we learn from the history of comets that several of the same kind have existed whose heads were formed not from one body but from several, and which likewise afterwards went off into different parts, and those parts were gathered together again. Among their number is rightly counted the comet that Nicephorus mentions in Book 12, Chap. 37 of the *Hist. Eccles.*, which shone a little before the strangling of Valentinian, in the year of Christ 392:

[Margin: De Cometâ Nieephori.] [recte: Nicephori] *On the comet of Nicephorus.*

"Then indeed," he says, "unusual portents were also seen, etc. For first an unexpected and unaccustomed star appeared in the sky at midnight, shining near the Morning Star [Luciferum], around that very circle which is called the zodiac. Because it was huge and bright with its flashing rays, it did not yield much to the Morning Star. Little by little, moreover, a huge mass of other stars also gathered to it. Had you seen that spectacle, you would have compared it to a swarm of bees flying in a circle round their leader. And the light that flashed out from all of them, as if from a mutual and violent collision, mingled into one single flame and presented the appearance of a great and dreadful two-edged sword, shining with a certain terror. For it was seen that the remaining stars fell back into the same [place], and that one star, and it alone, the one that had first been seen, appeared in its whole bearing like a root or a kind of hilt, and in some manner gave forth the brightness of that star that had been displayed; and just as a burning wick from a lamp, so the flame was raised on high."

Aristotle reports almost the same in Chap. VI of the book of the *Meteorology*: namely that Democritus held that comets are sometimes resolved into stars: "Democritus contended for his opinion, for he says that when comets were dissolved, certain stars appeared."

[Margin: Quâ facie Cometa an. 1652 in Americâ apparuerit ?] *In what appearance did the comet of the year 1652 appear in America?*

An almost similar example was observed in the case of the comet of the year 1652 in America, in a certain Parensian [Parenſi] city, commonly called Chuquiabo. Father Joh. de Königk of the Society of Jesus wrote of it to the celebrated Kircherus [Athanasius Kircher], and he in turn wrote to me on 1655 January 30: namely that in 1652, on December 15, new style, a twin comet appeared, with crossed tails, and with a third, very small one darting out from one of them. From this it is conjectured — provided, that is, that they did not stand far apart from one another (about which, however, the author reports nothing certain) — that they afterwards grew together into one body. For here in Europe only a single comet was seen a little later, namely on December 18 and 20; and in that form Father Königk himself also observed the comet at Cusco, and others too at Lima, Chuquisaca, Potosí and Oruto. So it is clear

from this that around its first rising there were two or three comets, but shortly afterwards only one appeared.

[Margin: Quinam ex veteribus, ſtatuerint Cometas ex diverſis conſtare corpuſculis.] *Which of the ancients held that comets consist of various corpuscles.*

Since, therefore, it has been handed down to memory that various examples of this kind have occurred, many of the older as well as of the more recent [writers] have for this reason embraced the opinion that the bodies of comets consist of various corpuscles and nuclei: for instance Anaxagoras, Democritus, Apollonius Myndius, Seneca, Zenon, Cardano, Cornelius Gemma, Jordanus Bruno [Giordano Bruno], Tannerus, Tycho, Mästlin, Helisæus Roslinus [Helisaeus Röslin], Tadeáš Hájek, Marcellus Squarcialupus, Ambrosius Rhodius, Thomas Fienus, D. Habrecht, Kepler, Snel, Erycus Puteanus, Liceti, Fromondus, Franciscus de Resta, Cysat, Libavius, Cabæus, Longomontanus, Eichstadius and very many others. And yet almost all of them, one and all, disagree greatly among themselves, and nearly every one of them holds his own particular opinion on the generation and corruption of these bodies.

[Margin: Variæ Veterum Opiniones de Cometis.] *Various opinions of the ancients on comets.*

For some think that the bodies of comets consist of old fixed stars, known long since, gathered together into one heap; others, of new stars created by God in the beginning; others, that they are a particle of the Milky Way; others, [that they are] consolidated aether; others again, that they draw their origin from the spots and faculae of the Sun — to pass over the remaining opinions, about which it is not to the point to say more here. For we have resolved, God willing, to record and examine these matters more clearly elsewhere. But what we ourselves think about these corpuscles and about the matter of comets — namely, from where it comes forth and takes its origin, and how comets really are born and perish — we shall set out at greater length in the next Book, where their origin and passing away will be treated expressly. To that Book are reserved many most useful and very difficult questions which could not yet be untangled in this Book.

End of Book VI [FINIS LIBRI VI.]

Johannes Hevelius, Cometography, Book Seven [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER SEPTIMUS.]

On the Origin, Genuine Matter, Form, Properties and Passing Away of the Comet of the Year 1652 as well as of All Others [De Cometæ,tam anni 1652,quàm aliorum omnium ortu, genuinâ materiâ, formâ, proprietatibus, & interitu.]

[Margin: Autor ſtatuit Cometas univerſos verſari in æthere.] *The author holds that all comets move in the aether.*

Since, therefore, the order of the work now seems to require that we treat of generation and corruption not only of our own [comet] in particular but of

all comets in general, it will not be out of place to point out at the beginning what we have already impressed many times in this work of ours, almost to the point of satiety, and have abundantly demonstrated: namely, that comets are placed not in our sublunary air but far above the Moon, in the highest aether, just like all the wandering celestial bodies; and that in it, like birds in the air and fish in the water, they have performed their motions most freely, without any resistance — in that most liquid and limpid ethereal matter, that is, which differs from our air only in purity. In it no solid and real orbs at all are found, as has indeed been loudly proclaimed both in the old age and by not a few of the more recent [writers] even now. But about this we shall speak at length in its proper place.

[Margin: In Cœlo nulli orbes reales dantur.] *There are no real orbs in the heavens.*

[Margin: Quid ſint Cometæ,ex mente Peripateticorum & Ariſtotelis.] *What comets are, in the view of the Peripatetics and of Aristotle.*

Since this is really so — namely, that all the ethereal matter poured round the celestial bodies is not in the least solid but supremely liquid, and that comets have moved in that same ethereal region far above the Moon — we shall therefore labour in vain if, with the whole troop of the Peripatetics, we go seeking the genuine matter of comets in these sublunary [regions], let alone in the very bowels of the Earth. The Peripatetics are thoroughly convinced that the matter of comets is a hot and dry evaporation, drawn up from the arid and dry earth into the highest region of the air; or rather, following their supreme leader Aristotle, that it is a hot and dry exhalation, smoky and somewhat fatty, fit to catch fire.

[Margin: Cometarum materia, circa corpora ætherea quærenda eſt.] *The matter of comets must be sought among the ethereal bodies.*

But in truth we must aim our thoughts much higher, and seek the origin of comets, and their matter and birth, nowhere but in the starry heaven, among those ethereal bodies. For their bodies certainly consist not of nothing at all but of some definite matter, since nature produces nothing without matter. But to imagine a body without matter is the mark of no philosopher, but of the most foolish of men: unless you would rather count the substance of comets, their origin and passing away, and all their attributes among the secrets of nature and the occult qualities; or [unless] we choose to ascribe them either to God, the Founder and Ruler of all things, or to certain Intelligences.

[Margin: Res naturales adDivinam referre omnipotentiam dedecet prorsùs Philoſophum.] *To refer natural things to divine omnipotence is wholly unbecoming to a philosopher.*

That, however, is wholly unbecoming to a natural philosopher: namely, to refer natural things straight away to divine omnipotence, or to take refuge at once in the asylum of the Intelligences — or, more truly, of ignorance — above all if other physical reasons perhaps still remain, by whose help their phenomena can be saved quite successfully. It will therefore be wiser for us to

stay a little while within the bounds of nature, leaving no stone unturned, so that we may see how far it is granted to reach in this matter. For the way of taking refuge in that sacred anchor, when no further remedy is left, will never be closed to us.

[Margin: Phyſicas reddere cauſas in Cometarum negotio res profectò ardua eſt.] *To give physical causes in the matter of comets is truly a hard task.*

It would indeed be a very easy matter if we were to lay down that comets are newly created by God through divine power, and began straight away from their creation: these lengthy disputes, believe me, would soon be brought to an end without much trouble. On the other hand, it must truly be admitted frankly, with many most distinguished men, that if we do otherwise and search out physical causes in this matter of comets, the task is very hard and wonderfully intricate. Accordingly both the greatest philosophers and mathematicians have, from the beginning until now, struck hard against this rock. And however much they have toiled over these matters, even to the utmost, and in devising almost innumerable opinions have left almost nothing untried, nevertheless scarcely any opinion remains in which nothing whatever is lacking, not to say one that deserves everyone's applause.

[Margin: Vtut vix omnibus hâc in parte à quopiam ſatisfieri poſſit, nihilominus tamen ſtrenuè deſudandum eſt, quò negotium iſtud magis magisq́; penetretur,clariusq́; reddatur.] *Although hardly anyone can satisfy everyone on this point, one must nevertheless toil vigorously, so that this matter may be penetrated more and more and made clearer.*

Therefore, well-disposed reader, I by no means persuade myself, nor would I have you persuade yourself — since I am not in the least to be compared with those great and most perspicacious men who have already toiled through this labour with so great an effort, and I am very well aware how meagre my stock of learning is — that I have firmly resolved to bring forward in this matter something most perfect in every respect and in every way most certain. Far from it, far from it indeed! Yet one should not lose heart altogether on that account; rather, we hold that we must strive with all our strength so that at least such things are brought forward as are not wholly absurd and [do not] seem utterly contrary to reason. I rely on the most certain hope that, with divine grace breathing upon [me], I shall make this matter somewhat clearer, at least in some respects if not in all; and that I shall treat the whole business — with both our own comet and certain others holding the torch before us — in such a way that our opinion may not seem to be the most absurd of all, much less to beget spurious and false consequences, but much rather to rest firmly on observations and phenomena. If we achieve that in these most difficult and highest matters, so far removed from our senses and imperceptible to them, we consider that we have fully done our duty, according to our small measure. But if you, kind reader, or anyone else, should be able to set before the world a truer opinion, by which the phenomena can be explained and untangled more correctly and more easily, not only will you be entirely free to do so, but I

myself, believe me, will embrace it with both hands in its time. For though Plato is a friend, and Aristotle a friend, yet Truth is a greater friend.

[Margin: Vt metcora in aëre, ſic nova aſtra & Cometæ in æthere procreantur.] [recte: meteora] *As meteors are produced in the air, so new stars and comets are produced in the aether.*

Since, therefore, the matter and birth of comets must now be sought by us in the highest aether, you can certainly conjecture easily, even if you view the matter only through a lattice, that we cannot declare otherwise than that both comets and new stars are generated, grow, decrease and are corrupted there — just as the new stars remain motionless in it, while the comets perform their motion in the same place — and that these adventitious bodies of the heavens are produced in the aether, among those eternal celestial bodies, in almost the same way as all meteors are produced around the Earth, namely in our sublunary air.

[Margin: In Cœlo dari generationem & corruptionem.] *There is generation and corruption in the heavens.*

From this it follows that the heavens are alterable, and that there is generation and corruption in them, increase and diminution, and alteration. Just as this doctrine is most strongly opposed to Aristotle's teaching on the heavens, so, believe me, it will not please the followers of that philosophy in the least. Nor, indeed, is that surprising, since it seems to destroy his whole philosophy and to overturn its foundations completely.

[Margin: Prægnantibus rationibus & indubitatis obſervationibus auctor adductus eſt, ad hanc ſententiam fovendam.] *The author was led by compelling reasons and indubitable observations to hold this opinion.*

But whatever the case, I cannot give up what I have begun, since I have been persuaded by compelling reasons and by the judgement of the senses, and led to this view: namely, that just as comets move in the heavens, so they also arise there and take their origin there. To this was added the fact that I have been convinced by indubitable observations, my own as much as those of many others, and have learned, that still more generations and corruptions of this kind are detected in the heavens besides. Not only are there stars newly born in the aether itself — some of them seen in their time growing and decreasing, which have long since perished, others still remaining motionless even now among the fixed stars themselves; among these one especially remarkable star occurs, which has now appeared in the Neck of Cetus for some years up to this very day, growing and decreasing (we have dealt with it expressly in a separate booklet) — but almost innumerable solar spots and faculae are also generated and corrupted near the Sun itself.

[Margin: Senſuum judicio ſtãdum eſt, ubi de re ſenſibili philoſophandum eſt.] *One must stand by the judgement of the senses when philosophizing about a sensible thing.*

Since, then, this way of philosophizing does not displease even Aristotle himself — for he bids us stand by the judgement of the senses where a sensible

thing is under discussion, and moreover wants the demonstration of a doubtful matter to rest on principles known through themselves and manifest to the senses — his disciples should not hold it against us if we enter on their master's path in philosophizing and arguing, laying down only what the observations themselves confirm and what experience and the senses clearly teach us: "from which, on pain of weakness of intellect, it is not permitted in the Peripatos to appeal," as Fortunio Liceti, that far from ordinary philosopher, rightly and aptly says in Book V, Chap. 68, p. 312 of *On New Stars and Comets*.

[Margin: Senſus principium eſt omnium noſtrarum cognitionum.] *Sense is the principle of all our cognitions.*

Likewise on p. 306 of the same book, Chap. LX: "Aristotle does not appeal from the senses." "For sense," as the same author advises in Book I, Chap. 2, p. 3, "just as it is the principle of all our cognitions, so it supplies us with true and solid foundations for acquiring knowledge of the most hidden things." Indeed, whatever escapes the senses is not known by the intellect either. If, then, we tread in these footsteps and follow this thread of Ariadne, we are admitted into the hidden inner sanctuaries without straying and without danger.

[Margin: Quid ſit Cœlum eſſe corruptibile & alterabile?] *What does it mean that the heavens are corruptible and alterable?*

But before we go on with our undertaking, it will be worth the effort first to explain our meaning correctly: how those statements are to be understood, when we have said that the heavens are corruptible and alterable, and that there are generations and corruptions in them. But there is no reason for you to persuade yourself that by this form of speech I maintain that the heavens are subject to generation and corruption as a whole; rather, [I] firmly maintain that this can happen only with respect to certain parts.

[Margin: Cœlum non ſecundùm totum ſedquasdam ſolummodò partes generationi & corruptioni obnoxium eſt.] *The heavens are subject to generation and corruption not as a whole, but only in certain parts.*

Indeed, just as this earth of ours and all sublunary things are generable and corruptible — not, to be sure, in respect of the whole, but only in respect of certain of their parts — so too is it with all the celestial bodies and with the whole heaven. For sublunary things can be compared with ethereal ones best of all, because, if we weigh the matter properly, they have a great kinship and a good many common inclinations and affections [paſſiones]; indeed, in very many respects they differ from one another very little, except in purity and tenuity and things like these.

[Margin: Vt Terra,ſic & Cœlum ex uno eodemq́; principio,ex iisdemq́; conſtat elementis.] *Like the Earth, so the heavens too consist of one and the same principle and of the same elements.*

For, first, the whole machine of the world — both the terrestrial globe and the heavens themselves, the former with all things whether animate or vegetable, the latter with each of the ethereal bodies, whatever are contained in this body of the world — was made and created by God, Best and Greatest [D E O O.

M.], out of that chaos created in the beginning. Just so, they also consist of one and the same principle and of the same elements. For I am entirely of the opinion that all the elements, such as fire, air, water and earth (if there are that many), as the principles of all things, or the prime matter, already lay hidden in that chaos, and that only afterwards were they separated, and transferred and distributed by the Creator himself into the bodies of the world, according to the condition and quality of each thing.

[Margin: Omnia Mundana corpora ad eandẽ divinæ artis amuſim eodem modocondita ſunt.] *All the bodies of the world were founded in the same way, to the same rule of divine art.*

From this we conclude, not wrongly: just as the whole of nature consists of one and the same principle, so too all the bodies of the world (as Kircher rightly and excellently says in the *Itinerarium Extaticum*, p. 24, in the Hortatory Prelude [Præluſione Paræneticâ]) were founded in the same way, to the same rule [amuſim] of divine art. They do not differ from one another in any respect as regards elemental matter, but are at variance with one another only through the diversity of their forms and properties. It is no different on the terrestrial globe: although innumerable species of things are found there to differ in forms and properties, all of them are nevertheless found to be the same as regards elemental matter.

[Margin: Materia illa, quæ Mundana corpora univerſa ambit,liquida, ejusdemq́; rationis & naturæ eſt, niſi quod puritate & tenuitate differat.] *The matter that surrounds all the bodies of the world is fluid and of the same character and nature, except that it differs in purity and tenuity.*

Second: it has been clearly established by reason and experience, by almost innumerable astronomers as well as philosophers — namely by the Venerable Bede, Verulam, Tycho, Clavius, Snel, Kepler, Ludovicus Molina, Scheiner, Borrus and Cabæus, to say nothing of almost innumerable others — that this matter, which surrounds all the bodies of the world, the Earth as well as the stars, and fills the whole space between the lower and the upper waters, as we have already said many times, is supremely fluid, and is one and entirely the same, that is, of the same character and nature; except that it is distinguished to some extent by purity and tenuity, so that the sublunary air surrounding the Earth is a little more dreggy [fæculentior] than the aether surrounding the celestial bodies.

[Margin: Æther non niſi puriſſimus eſt aër.] *The aether is nothing but the purest air.*

And, to take in everything in a word: there is one and the same medium from our Earth up to the outermost fixed stars; the aether, or ethereal air [auram æthream], is nothing but the purest and thinnest air, and conversely air is nothing but somewhat thicker aether.

[Margin: Vbi eadem materia, ibidem etiam eadem eſt eſſentia.] *Where there is the same matter, there too is the same essence.*

From this it is rightly inferred again and again that where there is the same matter, subtlety and transparency [diaphania], there too is the same essence. But there are generations and corruptions in the sublunary air; therefore there certainly are in the aether too, which, as we have impressed on you many times already, is nothing but the purest and thinnest air. The sum of it comes to this: since no material, and formal, difference between air and aether intervenes, and nature itself also recognizes no difference at all here, generations and corruptions occur alike in the air and alike in the aether, as in a similar medium of the world — and consequently both around the Earth and around all the celestial bodies — according to the condition and property implanted in those bodies by nature: not, to be sure, as a whole, but only with respect to certain parts, as will become more properly evident from what follows.

[Margin: Tellus noſtra innumeris penè generationibus & alterationib[9] eſt obnoxia.] *Our earth is subject to almost innumerable generations and alterations.*

Moreover, daily experience teaches us that both the earth itself, as regards certain parts, and its atmosphere are, by a certain natural necessity, subject to many most diverse and almost immeasurable generations, alterations and corruptions, without which, certainly, it could not otherwise subsist.

[Margin: Varii generis Meteora obſervantur.] *Meteors of various kinds are observed.*

[Margin: Meteora alia ſunt terrea, aquea, aërea, & ignea.] *Some meteors are earthy, [others] watery, airy, and fiery.*

For — to touch here only on those things, and to call them back to mind, that happen around the Earth, in its atmosphere and the sublunary air, by reason of exhalations and vapours (leaving out all those that occur both on the surface and in the bowels of the earth, around trees, plants, animals, buildings, metals, etc.) — we observe that many meteors of various kinds, earthy, watery and airy as well as fiery, are generated in those various regions. To say nothing at all for now of the earthy and airy ones, among which the wind and the threads of the Blessed Virgin [fila D. Virginis] are elsewhere counted, and to note only some of the watery ones, namely the principal ones: there are found mist, hoarfrost, clouds, snow, rain, hail, dew, etc. Of the fiery ones, however, far more occur, above all if it were necessary to mention each and every one here.

[Margin: Meteora ignita quædam in inferiore aëris regione, quædam in ſuperiori generantur.] *Some fiery meteors are generated in the lower region of the air, some in the upper.*

Among others, namely: in the lower region of the air, the flying dragon, the ignis fatuus, the licking fire [ignis lambens], the star Helena, Castor and Pollux, etc.; in the middle region of the air, the falling star, the burning lance, the thunderbolt, etc.; and in the highest region of the air, the torch, the perpendicular fire, the bolis, the leaping goat [capra ſaltans], flying sparks, the beam, etc. These meteors, I say — together with all the rest, which are deliberately passed over to save paper — arise only from the vapours and exhalations of the terrestrial globe. That is, the earth continually breathes them out in every

direction, all round, into its atmosphere and perpetually emits them; and it draws them back again, or they are pressed down to the earth by the force of the Sun's rays — more copiously and strongly, however, at one time than at another, according to the constitution both of its own body and of the Sun and the stars, which now greatly promote these exhalations and effluvia, now hold them back.

[Margin: Terra quo fine exhalationes in atmoſphæram continuò exſpiret.] *For what purpose the earth continually breathes out exhalations into the atmosphere.*

[It does so] to this end: partly that the air, which is supremely wholesome to plants and to all animals and most necessary to common life, may be purged, stirred up and sharpened; partly that the generations of sublunary things may be assisted universally.

[Margin: Circa corpora ætherea ſimiles, pro cujusvis corporis ratione, generationes & corruptiones accidunt.] *Around the ethereal bodies similar generations and corruptions occur, according to the nature of each body.*

It is almost the same with the other bodies of the world and the ethereal bodies: in them and around them, no less than on the Earth and in the atmosphere surrounding it, manifold generations, alterations and corruptions occur, according to the nature of each body. And yet it must not be denied that changes similar to our earthly ones cannot be detected in the celestial globes themselves, or on their surface, either with the naked eye or with the armed eye; indeed, although some may perhaps be present there, they nevertheless elude all keenness of sight. The chief reason is this: that because of their immense distance from us, this can by no means happen. Since no telescope at all has yet been invented, or is ever to be hoped for from human industry (in my judgement at least), by means of which reaching that far would be possible, so that all those things, each and every one of them however small, that exist on any body of the stars might be distinctly perceived.

[Margin: Vix Telèſcopium ullâ ratione expolietur unquam, quo quævis minima in globis cœleſtibus extantia deprehendi poſſint.] *Hardly will a telescope ever be perfected, by any means, through which even the smallest things standing out on the celestial globes could be detected.*

For this reason I hold it plainly wrong to settle anything certain about these things: even if reason does not altogether forbid it, it nevertheless by no means comes within the reach of the senses. But with regard to those generations and corruptions that occur around the ethereal bodies, in their individual atmospheres, the matter is far plainer, and for us entirely certain, because observations and the senses teach and demonstrate that these things are plainly so, as will soon become evident from everything that is to be said below.

[Margin: Vniverſa corpora cœleſtia ſuas habent atmoſphæras, in quibus ſuo modo generationes & alterationes accidunt.] *All the celestial bodies have their own atmospheres, in which generations and alterations occur in their own way.*

These generations and corruptions of which we are now speaking take their origin in almost the same way as those around the earth: namely from the effluvia of vapours and exhalations, which those ethereal bodies — being, like the earth, solid and opaque, and consisting of heterogeneous parts — likewise perpetually emit into their adjacent atmospheres [athmoſphæras] and breathe out all around.

[Margin: De exhalationibus & effluviis æthereis, quâ ratione ex corporibus effluant.] *On ethereal exhalations and effluvia: in what way they flow out from the bodies.*

These effluvia, however, are not altogether of the same kind. Rather, each body, according to its own condition and constitution, throws out various ones, as our earth does: now vaporous expirations [exſpirationes], now hot and dry ones (so to speak), now others of a different kind, according as [the bodies] differ from one another by the diversity of their forms and properties. Next, they also differ in this: that some breaths and outflows are now subtler and thinner than others, now denser and thicker. In accordance with this diversity, therefore, and with the differing nature implanted in them which those expirations possess, the lighter or the heavier they are (if I may be allowed to speak thus in our usual manner), the more or the less they move away from the body from which they issue, and are carried higher into the atmosphere and rise.

[Margin: Quinam Autores à partibus ſtent Autoris.] *Which authors stand on the author's side.*

In this, indeed, not a few of the learned agree with us: namely Plutarch, in the little book on the face of the Moon; Cornelius Gemma, on the portentous appearance of the comet of the year 1577; Kepler in the *Optical Part of Astronomy*, and also in the description of the new star in Serpentarius; Scheiner in the *Rosa Ursina*; Simon Marius in the *Mundus Jovialis*; Cabæus in the Commentary on Aristotle's books of *Meteorolog.*; Soares in the *Cursus Philosophicus*; Gassendi in the *Philosophia Epicuraea*; Kircher in the *Itinerarium Exstaticum*; and many others. Among their number — to say nothing of Pythagoras, Heraclitus, Thales, Plato and Proclus — a great many Fathers of the early age are also rightly counted, who asserted that the heavens do indeed consist of elements: namely Tertullian [Tertulianus], Basil, Ambrose, Jerome, Augustine, Theodoret and Cyril, a long catalogue of whom Martinengus gives in the great Gloss, vol. 1 [Tom. I.]; but to list them all here would take too long.

[Margin: Quâ ratione corpora ætherea juxta autorem evaporationes exſpirent.] *In what way, according to the author, the ethereal bodies breathe out evaporations.*

But so that you may grasp our meaning still more clearly: I hold firmly in my own mind that every ethereal body continually casts out and throws off exhalations and evaporations, or effluvia, from every part of its body — the thicker exhalations only into its adjacent atmosphere, but the thinner and purer

ones sometimes even beyond that atmosphere, into that most spacious ethereal field; though at some times in greater abundance and quantity than at others.

[Margin: Exſpirationes æthereæ diverſi ſunt generis, & qualitatis.] *Ethereal expirations are of different kinds and quality.*

These expirations and evaporations, likewise, are also of different kinds according to their inborn nature, and perhaps also of different quality: now dri- er [ones], which coalesce with difficulty; now moister and fattier [ones], which readily come together and condense. And, according to the condition of the matter, they form now subtler corpuscles, such as clouds and little clouds, now denser bodies, some of which are more durable and more tenacious than others.

[Margin: Ex tenuiſſimis corporum Cœleſtium effluviis Cometæ procreantur.] *Comets are produced from the very thin effluvia of the celestial bodies.*

From these effluvia and exhalations of the celestial bodies, I say — which at first are indeed extremely thin, indeed much thinner than our vaporous air, so that before they are condensed and consolidated they can in no way be perceived by the eyes — comets and new stars are also sometimes produced, now smaller, now larger in body and bulk, according as that matter is more plentiful in that part of the heaven, coagulates more readily, thickens and flows together copiously, and as the corpuscles and nuclei newly generated from it are gathered abundantly into one heap and are packed and consolidated more tightly.

[Margin: Exhalationes illæ Cœleſtes naturalem habent facultatem generationis, & corruptionis.] *Those celestial exhalations have a natural faculty of generation and corruption.*

For that ethereal matter, which is met with abundantly here and there throughout the whole heaven, has a certain promoting power and a natural faculty of generation and corruption, of increase and diminution, of condensation and rarefaction, of gathering and dispersal; and also a natural force both for producing such new, adventitious [adſcititia] bodies of the heaven and for destroying them and bringing them back in turn to their origin, from which they first came forth. In just the same way our earth, by the benefit of the rays of the Sun and of the planets, produces certain meteors, also disperses them again, and finally draws back the matter of which they were composed.

[Margin: Motus alterationis ut circa terram, ſic & circa reliqua corpora ætherea ſuo tamen modo accidit] *The motion of alteration occurs as around the earth, so also around the other ethereal bodies, though in its own way*

Finally, just as this motion of alteration is perpetual in our atmosphere, so too [is it] in the atmospheres of all the other celestial bodies — in each, however, after its own manner. For the things that happen on the earth under an earthly condition happen in Jupiter under a Jovial condition, in Mars under a Martial condition, in the Sun under a solar condition, etc.: that is, whatever takes place on the terrestrial globe (by reason — so that you understand the matter rightly

— of those effluvia), all of it likewise happens in its own way on the other bodies of the world.

[Margin: Haud adeò proclive probatu eſt, ætherea corpora eſſe ſolida, atq́; ex heterogeneis prorsùs conſtare partibus.] *It is not so easy to prove that the ethereal bodies are solid and consist entirely of heterogeneous parts.*

But, you will say, it is indeed asserted with the greatest ease, but demonstrated only with great difficulty, that all the ethereal bodies, each and every one, are solid, opaque, and composed entirely of heterogeneous parts; that they continually emit and throw out effluvia of breaths and vapours, of various kinds and differing quality, now denser, now thinner, both into the atmospheres that the individual celestial globes possess and also beyond them, into the most ample aether; and that these effluvia then, according to their nature, are gathered together, coagulated and condensed in the most diverse ways, and are again separated, thinned and dispersed, etc. For my part I readily grant that nothing is truer than that it is much easier to say than to do, and to speculate than to prove soundly that things really are entirely so in truth — especially concerning things extremely distant and remote, which by no means come within the senses so that they could be distinctly detected.

[Margin: Autor confidit ſe demonſtraturum,dari generationes, alterationesq́ue cœleſtes.] *The author is confident that he will demonstrate that there are celestial generations and alterations.*

However that may be, I have no doubt at all that I shall demonstrate most clearly all those things that we asserted a little before in the case of most of the bodies of the planets; and that in the rest too I shall deduce, by no less sound an inference, that they also are likewise of this kind, and that the same things can happen equally in most of them — if not from some necessity, at least with the highest probability.

[Margin: Deſcriptio Corporis Solaris ex ſententiâ Autoris.] *A description of the body of the Sun, according to the author's opinion.*

Now let us come to the matter itself, and begin with the chief, highest and most eminent celestial globe, the source of light and heat, that admirable work of the Almighty — the Sun, I say. Many believe its body to be most pure, most subtle, most smooth, most polished and most round, thoroughly diaphanous, and most uniform and most constant in its light. Nevertheless we have found by experience, very clearly, that the Sun has its opacity and solidity and consists of heterogeneous parts — namely of solid and liquid — and that its surface is not geometrically even, nor optically polished, but only astronomically spherical, like the billowing sea of the earth, and like the Moon, rugged with mountains and valleys, as Scheiner puts it in the *Rosa Ursina*, Book 4, Part 2, Chapter 11, p. 604 [Roſâ Urſinâ Lib. IV. P. II. Cap. XI. pag. 604]. The Sun is by no means wholly luminous and pure, but has parts that are partly darker and partly brighter; and in it, moreover, a continual succession of changes and a wonderful alternation of rarefaction and condensation are plainly detected. So we are not afraid to say — as we shall also set out clearly later — that no body

exists in the whole world that is subject to so many alterations and vicissitudes as the Sun itself.

[Margin: Nullum Mundanorum corporum majoribus alterationibus & vicisſitudinibus eſt obnoxium, quàm corpus Solare.] *None of the bodies of the world is subject to greater alterations and vicissitudes than the body of the Sun.*

But to reveal our meaning to you still more clearly concerning this immense and truly admirable body of the Sun: know that I, with innumerable eminent learned men, hold firmly that [it] consists, as we have just said, of two especially different parts, namely solid and liquid.

[Margin: Sol conſtat ex partibus ſolidis & liquidis, igneis ſcilicet lucidisſimis.] *The Sun consists of solid and liquid parts — fiery ones, that is, and most luminous.*

The solid parts, however, are not altogether like these earthly ones of ours (except that [it] likewise has its eminences, or mountains, and concavities, or valleys), but by their nature are most luminous and most splendid; nor are its liquid parts in any way comparable with ours. For they are not aqueous or watery, or anything of that kind; rather, it is a most liquid, most thin and most luminous fiery matter, which is enclosed and contained by the more solid matter of that same [body] just mentioned, in just the way that water is by the earthy parts.

[Margin: Materia liquida in Sole eſt verus & realis ignis elementaris.] *The liquid matter in the Sun is true and real elemental fire.*

For the solid solar parts perform in the Sun what the earth [performs] on this terrestrial globe; and likewise the liquid solar parts perform in the Sun what the water [performs] there. I add that this very liquid matter is true elemental fire [ignis elementaris]: not indeed so dreggy, impure and thick as our fire, but much purer, more refined and thinner, needing not even the least nourishment; or, if perhaps it has need of it, it supplies from its bowels, caverns and passages so much nourishment that it can always be kept in vigour — just as our fire-spewing mountains, Vesuvius, Etna, Hekla and others, which have been blazing since the world was founded and are by no means burnt away, perpetually belch out and cast forth sharp and raging flames, and yet are never consumed.

[Margin: Materia liquida illa Solaris nullas fundit flammas, ſedfumos vaporesquè tantum ejicit.] *That liquid solar matter pours out no flames, but casts out only smokes and vapours.*

Further, however much this liquid matter is kept in a perpetual agitation of heat [æſtus], it nevertheless conceives no flames, much less pours them out and darts them forth; but perpetually it only casts out and breathes out smokes and vapours, like boiling water or some very hot liquid. Nevertheless it is true and real fire, and as it is most luminous, so it is also most burning: so much so that in the Sun is found that genuine elemental fire which the Peripatetics have sought until now beneath the concave of the Moon, but in vain.

[Margin: In Sole ignis elementaris quærendus non ſub Lunæ concavo.] *Elemental fire is to be sought in the Sun, not beneath the concave of the Moon.*

For [it was] transferred into the Sun by God, Best and Greatest [D E O O. M.], at the first creation, together with the primordial light — or rather, [it is the fire] out of which the body of the Sun origi- nally was composed — as Kircher rightly holds in the *Itinerarium Exstaticum*, p. 148 [Itinerario Exſtatico pag.148]: *that the Sun is the first fire of corporeal fires, and the true element of fire in this sensible world, the most compacted light of the primeval light and heat, and a most fervent and most burning fire.*

[Margin: Kircheri ſententia de admirando Solis corpore.] *Kircher's opinion on the admirable body of the Sun.*

[Margin: Corporis Solaris plenior deſcriptio.] *A fuller description of the body of the Sun.*

And so this fiery liquid (if one may speak thus) is as it were a most vast ocean of lights and a fiery sea, which has its abysses, hidden channels, gulfs and whirlpools; which, like our sea, is agitated by certain perpetual rollings of waves, and in its own way continually vomits out and exhales evaporations and exhalations — and this the more or the less, according as that matter in its bowels and inmost recesses, that fiery ocean, and its waves are the more or the less moved and stirred up.

[Margin: Ex circumrotatione corporis Sclaris fluxus & refluxus Pelagi illius ignei oritur.] [recte: Solaris] *From the circumrotation of the solar body arises the flux and reflux of that fiery ocean.*

This commotion and agitation, moreover, is all the more vehement, and the forces for thrusting out and throwing off vapours are all the more keenly intensified and roused, because the Sun is engaged in a certain perpetual circumrotation, completing one revolution about its axis in every twenty-seven days or so. From this arises a definite circulation of the fiery solar ocean, and an alternation of flux and reflux; so much so that it is no wonder that the Sun can emit and belch out so many and such great effluvia from this continual and more vehement commotion. From these effluvia, in their own time, when those breaths are condensed and gathered together, so many and such great spots and faculae of the Sun are generated and produced.

[Margin: Prope Solem dari maculas, & faculas varii generis.] *That near the Sun there occur spots, and faculae of various kinds.*

As we have clearly ascertained from observations, such spots quite often occur near the Sun, both fainter ones and more compact, blacker and denser ones; and also faculae of various kinds, little lights [luculas], shadows and mists, now larger, now smaller — indeed some that, compared with the earth, are of unusual size. In these spots and shadows, too, more compact and very dense nuclei are frequently seen; and these, together with the spots themselves, sometimes reach such density and opacity that they allow absolutely no passage to the very light of the Sun, so extremely intense as it is, a light to which nothing whatever in the world is comparable. Moreover, I would have you know that these spots are generated in every part of the Sun, and so also sometimes in

the very middle of the disc, and that there too, shortly afterwards, they are consumed and dispersed again.

[Margin: Mira macularum facularumq́; Solarium mutatio, atq́; vicisſitudo.] *The wonderful change and vicissitude of the solar spots and faculae.*

Not rarely, too, they undergo wonderful changes: now very dense spots are born from very faint shadows and faculae; now these in turn are transmuted and resolved into shadows and faculae. So a continual vicissitude, generation, alteration and corruption of these things — whenever, that is, such matter is supplied — plainly appears and is observed not far from the Sun itself (since no parallax is ever detected in them).

[Margin: Maculæ Solares ex effluviis & evaporationibus Solis promanant.] *The solar spots flow forth from the effluvia and evaporations of the Sun.*

This matter, now, is that very evaporation and exhalation (since it can by no means arise from anywhere else) which, as was shown above, is breathed out and exhaled from the very body of the Sun; and these consist entirely of diverse heterogeneous parts, having definite degrees of opacity and density — now of thinner, now of more opaque, now of drier, now of more viscous, glutinous (to speak in our customary way) or bituminous ones. From this, too, diverse phenomena are produced: from the thinner, purer and drier [parts], namely, shadows, faculae and little lights; but from those impurer, coarser, viscous [ones], spots, and of these same the nuclei are engendered.

[Margin: Solem ſuam habere atmoſphæram, in quâ alterationes etiam noſtris frequentiores accidunt, luculenter deducitur.] *It is clearly deduced that the Sun has its own atmosphere, in which alterations occur even more frequent than ours.*

Since, then, the exhalations of the Sun are heterogeneous parts of this kind, why should not that very body which ejects them also consist of diverse heterogeneous parts, as was asserted at length in the preceding [pages]? Moreover, we see such admirable and most manifest generations, changes, alterations, condensations, rarefactions, comings-together and separations — indeed local motions of bodies, and of the things and materials ejected and evaporated from the Sun itself — carried out almost continuously, like the clouds and sublunary meteors that flow forth from the earth. Since we see this, is it not clearly proved from it that the Sun has its own atmosphere, and that in it, according to the character of its power, there occur generations and corruptions not unlike [those of] sublunary things, and rarer [?] — indeed, that sometimes far more frequent and more remarkable ones occur there (especially if you examine exactly the observations of the spots made by Scheiner and by us) than can ever [occur] near this earth?

[Margin: Aliis rationib⁹ probatur dari atmoſphæram circa Solem.] *By other reasons it is proved that there is an atmosphere around the Sun.*

Although these [arguments] would suffice, so that no further proofs would be needed as regards the Sun, it can nevertheless be deduced without difficulty from still other reasons and observations that there is an atmosphere, and that

in it that matter of the aether is not always equally thin, but alterable — and indeed sometimes much denser and coarser.

[Margin: Sol quandoq́; exutus prorsùs radiis cœlo etiam ſereno conſpectus eſt.] *The Sun has sometimes been seen altogether stripped of its rays, even with a clear sky.*

Above all, [it is deduced] from those phenomena that have occurred around the Sun, when the Sun, over a space of several days, and indeed in different places, appeared now paler than usual, now ruddier, indeed altogether stripped of its rays, although the sky was quite clear, so that even the stars shone out clearly by day, and indeed at noon. 1. In the time of the Emperor Justinian, as Patricius [Francesco Patrizi] reports from Petrus Messia [Pedro Mexía], *Pancosmia*, Book 19, p. 111 [Lib. XIX. Pancoſm. pag. 111]: *for the greater part of the year, with the air clear and veiled by no cloud, the Sun shone so feebly that its light scarcely exceeded the brightness of the Moon.* 2. As Paulus Diaconus notes, the Sun was darkened in the year 790, and for 17 days did not give its rays. 3. On the testimony of Pliny the Elder, the Sun was pale for a whole year after Caesar the Dictator was killed. Tertullian writes that something similar happened in the time of Augustus, and Kircher reports that it was also observed in 1652.

[Margin: Sol adeò obtuſo lumine eſt obſervatus ut etiam Stellæ in meridie conſpectæ fuerint.] *The Sun has been observed with so dulled a light that even the stars were seen at midday.*

4. In 1547 Gemma Frisius and Cornelius, [his] son [Cornelius Filius], observed that for three days the Sun appeared as if suffused with blood, but most of all toward sunset, so that even most of the stars were seen at midday. Josephus Scaliger [Joseph Justus Scaliger], as a boy of 7 years, also saw the same phenomenon, from April 22 for four whole days, as he himself testifies in the *De emendatione temporum*, Book 5, on the year of the murder of Caesar [de anno, cædis Cæſaris]; and it was noticed not only throughout the Low Countries [Belgio], but likewise by others in France, Germany and Britain.

[Margin: Sol inſtar ferri candentis apparuit Cæſariopoli.] *At Caesareopolis the Sun appeared like glowing iron.*

5. David Frölichius [David Frölich] observed a phenomenon of this kind at Caesareopolis [Kežmarok], as is clear from his letter written to me in the year 1645: "I myself," he says, "on April 25, New Style [25 April. ſt. n.], at 3^h in the afternoon [hor. 3 veſpertinâ], saw the body of the Sun like glowing iron, or a tawny Moon, altogether deprived of its rays." Far more examples of this, too, are met with in the histories.

[Margin: Cauſſa pallidi & obtuſi luminis iſtius Solaris, nonniſi in atmoſphæram ejus referenda eſt.] *The cause of that pale and dulled solar light is to be referred to nothing but its atmosphere.*

If, now, we inquire into the cause of the overshadowing and obscuring, or of the pale and dulled light, of the Sun, it can by no means be drawn from our sublunary air, or from earthly vapours and exhalations, still less from clouds;

it will surely have to be sought elsewhere. For if that interposed matter had been in our atmosphere — believe me — those phenomena would neither have lasted so long, nor have been so univer- sal that they were observed in exactly the same way throughout different regions (as indeed happened above all in 1547) — to say nothing of the fact that the Sun alone, by itself, could by no means have appeared ruddier and paler than usual, since at that time the sky was very clear on all sides, so that even the stars sparkled at midday.

[Margin: In Sole nonnunquam ſævæ & inſolitæ tempeſtates & inundationes oriuntur.] *In the Sun fierce and unusual storms and floods sometimes arise.*

Since this is so, that genuine cause must therefore be searched for nowhere but in the aether itself — and indeed in the very atmosphere of the Sun. And so I fully believe that at that time fierce storms and unusual floods arose in the Sun (for it is not absurd that [it] too sometimes suffers its own paroxysms and its own vicissitudes), and that it then poured out and emitted a great quantity of vapours and smokes into its atmosphere or vortex [verticem]. These expirations, once they had spread out and condensed to such a degree, like a huge, thinner spot or very dark clouds, that they overshadowed the whole Sun entirely, in part [?] [ex parte], and in a way closed off the path to its rays, [the Sun] necessarily appeared bare of rays and altogether despoiled.

[Margin: Quâ ratione Sol pallidior, obtuſior,&rubicundior appareat.] *How the Sun comes to appear paler, duller and ruddier.*

From this it came about that the Sun, at this time or that (in proportion to the greater and lesser density and diversity of that nature), was seen now paler and duller, now ruddier and darker. Kepler, a man of penetrating intellect, also had an inkling of this long ago, as one can read in the *Astronomiae pars optica* [Aſtronomiæ parte Opticâ], Chapter 6, no. 11, p. 259 [Cap. VI. n. 11. pag. 259]; and likewise in the book *De stella nova in pede Serpentarii* [Libro de novâ Stellâ, in pede Serpentarii], Chapter 23 [Cap. XXIII], where indeed he deduces that the matter of the heavens is alterable, and that the [matter] which dulled the light of the Sun, but by no means that of the stars, had settled neither in our vaporous air, nor below the Moon, nor near it, but in the highest aether. For he says: *It is therefore to be sought in the deep aether, very close to the Sun, between it and the earth; indeed, offered to us from there, it is to be embraced as an argument for the mutable ethereal matter which is poured, liquid, around the stars.* But we must not dwell on these things any longer; let us turn to the Moon.

[Margin: Corporis Lunaris deſcriptio : quod ſit opacũ, aſperum; atq; ex partibus ſolidis & liquidis conſtet.] *A description of the body of the Moon: that it is opaque and rough, and consists of solid and liquid parts.*

That the body of the Moon is most opaque, rough, rugged, full of mountains and valleys; that by its opacity it denies passage to the light of the stars, indeed of the Sun itself; that it consists of most diverse parts, earthy as it were (but according to its own nature) and watery — solid and liquid: mainland, seas, lakes and marshes, islands and promontories; and that its matter, moreover, is not altogether uniform but extremely diverse, as all can gather from those various

colours met with here and there on its surface — this, I think, is now hidden from almost no one in the learned world any longer, and no one can deny it. It has been discovered more than enough in our age, and also demonstrated abundantly to the eye of the whole world, in Chapter 8 and especially Chapter 13 of the *Selenographia* [Cap. VIII. & imprimis Cap. XIII. Selenographiæ].

[Margin: An Luna etiam habeat ſuam atmoſphæram ?] *Does the Moon too have its own atmosphere?*

So it is not pertinent to say more about these things here; it remains only to investigate whether the Moon, like our earth and the body of the Sun, likewise enjoys an atmosphere of its own, into which it exhales and breathes out evaporations and exhalations no less [than they], though in its own way; and then, in which, according to the faculty implanted in it, similar alterations, condensations and rarefactions take place.

First of all, I do not deny that this very thing is harder to demonstrate in the Moon than in the Sun itself, since such manifest and detectable observations are entirely lacking, and those changes near the Moon are not so sen- sible, nor do they come so frequently into everyone's view, as [they do] near the Sun.

[Margin: Evaporationes Lunares haud adeò facilè quàm Solares deprehenduntur.] *Lunar evaporations are not detected as easily as solar ones.*

Nevertheless, it is not contrary to reason that there too, to some extent, effluvia and certain expirations occur. For the Moon is composed of purely heterogeneous parts, of diverse opacity; its surface is filled with various lakes, marshes and seas, surrounded on all sides by fairly high mountains, not altogether unlike ours; and besides, because of its nearness, it is most exposed to the rays and forces of the Sun and of the other planets. I consider, however, that these lunar evaporations themselves are far thinner and purer than the solar and terrestrial ones, so that it is very difficult for anyone to detect them, whether with the naked eye or with an eye armed with even an excellent tube.

[Margin: Singulare phænomenum in Lunâ ab Autore deprehenſum.] *A singular phenomenon detected in the Moon by the author.*

Yet on separate occasions I have found by experience that the Moon and its spots did not appear to me equally bright, clear and transparent at all times — even when the sky was clear on all sides, so that I could make out little stars of the sixth and seventh magnitude, with the Moon at the same altitude and the same elongation from the earth, and moreover with one and the same excellent telescope. Rather, at one time and another they were seen far brighter, clearer and purer (a thing which, as new and unusual, I have certainly wondered at not a little, and quite often).

[Margin: Dari circa Lunam alterabilem materiam vaporoſam.] *That there is alterable, vaporous matter around the Moon.*

Here I ask: what is the reason for this phenomenon? Truly, however much we weigh the matter, we can assign no other, truer cause than that around the Moon itself there is some alterable matter — now thicker, rarer, now denser and thinner — like clouds and very thin shadows, which, although they sometimes

fill our air, still do not altogether hide the stars, but only show them somewhat more nebulous; or like very subtle shadows and the subtler matter of the solar spots, which not infrequently veils the Sun in some way in this or that part, so that its colour appears paler or gloomier there.

[Margin: Materiam Cœli quandoque eſſe ſubtiliorem.] *That the matter of the heavens is sometimes subtler.*

This matter, I say, renders the lunar spots and the Moon itself, at different times, according to the constitution of the evaporated matter, now somewhat gloomier and paler, now clearer and brighter.

[Margin: Vaporoſus Orbis circa Lunam aliis obſervationibus & rationibus probatur.] *A vaporous orb around the Moon is proved by other observations and reasons.*

But it can be proved still more evidently, from certain total eclipses of the Sun that have been observed, that exhalations and a certain vaporous, alterable matter are sometimes found around the Moon. Kepler did this at sufficient length and admirably in the little book *De stella nova Serpentarii* [libello de novâ Stellâ Serpentarii], Chapter 23, p. 115 [Cap. XXIII. pag.115], from the eclipse of the Sun observed at Naples and Antwerp in the month of October, in the year 1605. At that time, when the whole Sun was covered by the Moon, a red and flaming redness of equal breadth on all sides, which had occupied a good part of the sky, was detected all round the periphery of the Moon; so that, for this cause and by reason of this brightness, no stars at all could then be seen in the whole Kingdom of Naples, although the whole Sun was entirely covered by the Moon (for the diameter of the Moon exceeded the size of the solar diameter).

[Margin: Tempore Eclipſeos Solaris nonnunquam Stellæ clarè affulgent.] *At the time of a solar eclipse the stars sometimes shine brightly.*

Whereas at another time total eclipses have brought on astonishing darkness, so much so that even the stars met the eye in abundance. Such was the [eclipse] of 1560 August 12, which Clavius recorded, and several other eclipses, which Kepler mentions in the *Astronomiae pars optica* [Aſtron. Parte Optic.], Chapter 8, no. 2, p. 292 and following [Cap. VIII. n. 2. pag. 292 & ſeq.]. With these and other examples and reasons, on pp. 115, 117 and 118 of *De stella nova Serpentarii* [de Stellâ novâ Serpentarii], he concludes: this cir- cle and the brightness surrounding the Sun were nothing but solar rays refracted in a certain denser matter very close to the Moon, by means of which that glare and brightness was carried to our eyes. This, however, could by no means have happened if no other matter, thicker than the aether, had surrounded the Moon. For the said author presses the point in these words: *The matter by which this brightness of the Sun was received must by no means have been lower than the Moon, but poured around either the Moon or the Sun itself, or at any rate poured in between both luminaries, and so in the aether.* Likewise on p. 119: *Therefore it was not the air poured over us, but some loftier and wholly celestial matter, that cast this brightness, received from the Sun, around the Moon.*

[Margin: Circa Novilunium juxta Solem Luna obſervata eſt.] *Around the new moon, the Moon was observed beside the Sun.*

That such somewhat thick lunar and solar matter sometimes clings in the neighbourhood of both luminaries, and there gradually becomes more and more consolidated and attenuated, indeed is entirely dispersed again, is detected no less from a certain observation made at Seville [Hiſpali]. For in the year 1553, in the month of February, around the new moon, the Moon was seen by the whole city standing beside the Sun at noon itself. From this phenomenon, in turn, together with the frequently cited author Kepler, we conclude *that the matter of the heavens, since at different times it is of a different subtlety, differing greatly from itself, also sometimes absorbs more brightness than at other times; and so it blinds men's eyes now more, now less, in seeing stars by day* (*De stella nova Serpentarii* [Libell. de novâ Stellâ Serp.], Chapter 23, p. 120 [Cap. XXIII. pag. 120]).

[Margin: Argumentum pro Atmoſphærâ Lunæ.] *An argument for the atmosphere of the Moon.*

For the rest, that vaporous orb around the Moon is established by a still more solid argument: in certain total eclipses of the Moon a certain small portion, brighter than the remaining, darkened part of the Moon, is clearly detected, like little lights [luculæ] and faculae — not, indeed, remaining long in the same place, but mobile and variable. Whereas, however, no light at all of its own inheres in the Moon, but it draws all that it has entirely from the Sun. This is shown both by its phases [and] the solar eclipses, and by the total eclipses of the Moon at times — namely, when the Moon is so covered and darkened by the earth's shadow that it can scarcely, or not even scarcely, be made out in the sky, even by those skilled in astronomy, as we said at length in Chapter 6, p. 116 of the *Selenographia* [Cap. VI. pag. 116 Selenographiæ].

[Margin: Notabilis Eclipſis Lunaris, in quâ luculæ diverſæ apparebant.] *A notable lunar eclipse, in which various little lights appeared.*

Among the most notable eclipses of this kind, however, the one that presents itself above all is the one that I myself happened to observe in the year 1642, on April 15/25. In it, at the time of greatest obscuration, although the air was clear on all sides, so that even the smaller little stars were seen perfectly well by everyone, the whole Moon nevertheless vanished altogether, so that scarcely, at intervals, some very tiny little lights here and there on the lunar body came into view. Again, at other times, when likewise it can in no way be illuminated by the Sun, it nevertheless pours out some light — as usually happens at the time of new moon in the fresh and horned phases, and also in certain total eclipses.

The first, as we deduced at length in the same Chapter 6 of the *Selenographia* [Capite VI Selenog.], is that light reflected from the earth. The other, however — which shows itself scattered, like a little light, in the Moon when it is entirely darkened, and indeed always about the limb farther from the ecliptic — takes its origin from nothing but the atmosphere itself, or the lunar vaporous orb, in which the solar rays, as in some denser medium (just as happens to the same

rays in our twilight air, so that for that reason it must grow light and become day a little sooner than could otherwise happen) are refracted and projected onto the Moon. In this way certain small parts of the Moon are illuminated here and there, and are seen like little lights or faculae.

[Margin: Inſigne phænomenon in deliquio Lunari 1635 detectum, pro ſtabiliendâ atmoſphærâ Lunæ.] *A remarkable phenomenon detected in a lunar eclipse in 1635, for establishing the atmosphere of the Moon.*

This has likewise been noted several times in the eclipsed Moon, above all in the year 1635, on March 3, and again on August 27 of the same year, in those total eclipses. For in the former [eclipse], which then had a southern latitude, a notable glare was detected — not, indeed, always fixed in the same place, but variable; yet in such a way that it always remained about the southern limb. In the other eclipse, however, which was at that time in southern latitude, they observed an almost similar phenomenon, but in the northern part of the limb. This light can by no means arise from anywhere else than from the fact that the solar rays are refracted in the vaporous orb poured around the Moon (which is perhaps so ample that it far exceeds even our twilight atmosphere).

[Margin: Atmoſphæra Lunæ tam noſtrã atmoſphæram crepuſculinam, quàm umbram terrenam vaſtitate vincit.] *The atmosphere of the Moon surpasses in vastness both our twilight atmosphere and the earth's shadow.*

And although the Moon is in the very middle of the shadow, nevertheless in that atmosphere of the Moon, which is greater than the earth's shadow, the solar rays are always received in such a way that they must always pass through obliquely, and so refracted — and indeed towards the Moon. By means of these refracted rays a small portion of the Moon is illuminated here and there, according to the different refraction, or the various degrees of density of that matter.

[Margin: Quâ ratione luculæ in Eclipſes Lunares inducantur.] *How the little lights are brought into lunar eclipses.*

Moreover, since the Moon, by its proper motion, together with its vaporous orb, continually advances according to the order of the signs, this glare too, therefore, does not always remain in the same place, but migrates into one [place] after another. [This is] because the Sun with its rays strikes successively one part of the vaporous orb after another, and in this way refracts the rays now one way, now another — namely to the perpendicular, towards the Moon — so that these little lights can in no way be long-lasting, but continually variable: as this very thing could be demonstrated more clearly by a certain diagram, if we wished to dwell on these matters longer; but I judge that we must hurry on.

[Margin: Ex Deliquiis Solaribus infertur, dari Atmoſphæram Lunarem.] *From solar eclipses it is inferred that there is a lunar atmosphere.*

And that all this is so, partial eclipses of the Sun also show. For as I weighed this matter somewhat more closely, it came to my mind that in some eclipses I had detected an unusual fluctuation of the lunar limb, whereas around the solar limb nothing, or very little indeed, of that trepidation was perceived. This,

truly, I have nowhere else to refer than to [the fact] that there is a definite atmosphere around the Moon, in which matter, now thinner, now denser, is met with, which is subject to condensation, rarefaction and alteration. Through this matter, therefore, which refracts the lunar rays in various ways, we see the limb of the Moon sometimes trembling and fluctuating.

[Margin: In EclipſiSolari anno 1618, limbus Lunæ valdè fluctuabat.] *In the solar eclipse of the year 1618 the limb of the Moon fluctuated greatly.*

A certain eminent mathematician was likewise led to this opinion when he observed an almost similar phenomenon around the limb of the Moon at Barcelona [Barcinone], in the year 1628, on December 25, in a solar eclipse — as one may read in Scheiner, *Rosa Ursina*, Book 4, Part 2, Chapter 27, fol. 740 [Lib. IV. Part. I I. Cap. 27. fol. 740.]: *I observed* (says that mathematician, whose name Scheiner keeps silent) *in the same eclipse a thing to be wondered at in the Moon placed beneath the Sun: namely, the periphery of the Moon fluctuated and trembled very greatly, the periphery of the Sun trembling either not at all or very little, no differently than a sea agitated by waves, with wave driving wave. From this I concluded that the sphere of the Moon is surrounded by a certain atmosphere no smaller, and perhaps thicker, than the earth is [surrounded]. Let the Reverend Father see whether I have rightly con- cluded. Certainly I find no other cause why, at the same altitude of the Sun, the periphery of the Moon always trembled much more than the periphery of the Sun, except this: that the solar rays had been cut off by the vapours surrounding the Moon.* He adds: *From this a greater light seems to arise for the solar spots and the comets, if, as from the globe of the earth and of the Moon, so also from the globes of the remaining planets vapours are breathed out.*

[Margin: DeLunæ atmoſphærâ Scheineri & Kircheri judicium.] *The judgment of Scheiner and Kircher on the atmosphere of the Moon.*

These are his words. But what Scheiner, a man endowed with a truly polished judgment, thought on this matter can be seen clearly on the same cited page; for he says: *That learned mathematician, a most exact observer, wrote these things to Rome in the year 1629, on January 12. What fallacy there is in his acute reasoning, astronomers have not yet discovered.* Kircher reports something similar in his *Ars magna lucis et umbrae* [arte ſuâ magnâ Lucis & umbræ], Book 1, Chapter 3, p. 13 [Lib. I. Cap. III. pag. 13.]: namely, that Father Cysat (unless he himself, since he was staying at Barcelona at the same time, is the mathematician whose name Scheiner passed over in silence) detected in the same eclipse an orb of vapours and exhalations around the Moon; he adds moreover: *I do not doubt that the same happens in the remaining globes of the planets, which, just as [they have] centres different from the centre of the universe, so also constitute different spheres of exhalations.*

[Margin: Cyſatus circa Lunam Orbem vaporoſum deprehendit.] *Cysat detects a vaporous orb around the Moon.*

Cysat wrote almost this very thing, but in other words, from Barcelona to Father Juan Eusebio Nieremberg [Pat. Joh. Euſebium Nierembergium] in the year 1628, as is evident from his *Historia naturae* [Hiſtoriâ Naturæ], Book 2,

Chapter 11 [Lib.II. Cap. XI.]; [his words] truly deserve to be attached here: *And indeed in the recent solar eclipse, which fell on the very day of Christ's Nativity, I clearly observed in the Moon, opposite the Sun, something that strongly proves the very point that the comets and the solar spots also press, namely that the heaven is not exempt from the thinness and the variations of the air. For I noticed that around the Moon there is a sphere, or a certain vaporous orb, no differently than around the earth, so that, just as vapours and exhalations are breathed out from the earth up to some sphere, so too in the Moon. If Your Reverence had been with me and had inspected the Moon under the Sun, I would have demonstrated to Your Reverence what I say, both by reason and to the eye; now I, for my part, know it.* Thus far Cysat. This is also most true; and from it — especially from all the things brought forward above — it is rightly concluded that vaporous orbs exist around the remaining planets no less than around the Sun and the Moon.

[Margin: Quinam inter Autores huic ſententiæ de Lunæ atmoſphærâ ſubſcribant.] *Which authors subscribe to this opinion on the atmosphere of the Moon.*

Not a few of the most distinguished men, too, defend this atmosphere of the Moon together with us: as Plutarch, in the book *De facie Lunae* [lib. de facie Lunæ], Chapter 45; Mästlin; Kepler, in the preface to the *Ephemerides*, p. 9, the *Epitome Astronomiae* [Epit. Aſtron.], Book 1, p. 57, likewise Book 3, p. 893, and the book *De stella nova Serpentarii* [Lib. de novâ Stellâ Serp.], Chapter 23 [Cap. XXIII.]; David Fabricius, in the Prognostication [Prognoſt.] for the year 1626; Giordano Bruno [Jordanus Bruno], in the book *De immenso* [Lib. de immenſo]; Longomontanus [Longomont.], Book 1 of the *Theoricae* [Lib.Theor.I.], Chapter 4; Marius Bettinus [Mario Bettini], Apiar. 8, Prog. 2, prop. 10 [Apiar.VIII.Prog.2.prop.10.]; Antonius Maria de Rheitâ [Anton Maria Schyrleus de Rheita], Book 4, Chapter 2, Member 10 of the *Radius Syderomysticus* [Lib.IV. Cap. 2. Memb.10. Radii Syderomyſtici]. For he says: *since the new astronomical spyglass, excellent and very long, show its body to be solid, and also most plainly surrounded by its own atmosphere, just as our earth is, or by vapid air [vapido aëre], I truly do not see by what reasoning we should deny it the other elements.* Wendelen asserts the same in the preface to the *Eclipses lunares* [præf. Eclipſium Lunar.], p. 5: *The earth* (he says) *is surrounded by its own air, and the Moon likewise by its own, perhaps no purer than this of ours.* Above all, however, Mästlin, a man of the sharpest intellect, testifies in these words, in a certain little book of theses published at Tübingen in the year 1606, that alterations occur in the Moon, indeed that he had seen rains in the Moon: *In the lunar eclipse on the evening of Palm Sunday in the ye- ar 1605, a certain blackish spot was seen in the body of the Moon, towards the north, darker than all the rest of the body, which presented the shape of red-hot iron. You would have said they were clouds spread over a large region, heavy with rainy and stormy showers, of the kind that one not rarely sees [moving] from the ridges of the higher mountains down into the lower places of the valleys.*

[Margin: Mirum phænomenum in Lunâ conſpectum.] *A remarkable phenomenon seen in the Moon.*

And do not think, says Kepler, *that it was one of the old spots: Mästlin himself showed me the diagram the year before. The spot differed both in position and in size: for it occupied about a fourth or a fifth part of the lunar surface, and was, besides, so black that it stood out even in the darkened Moon.* Johannes Phocylides [Johannes Phocylides Holwarda] adds, moreover, on p. 268 of *De novis stellis* [de novis Stellis]: *Although this was a certain extraordinary fumigation of evaporating exhalations, certainly greater than usual, it nevertheless shows us clearly how much she [the Moon], like the other planets too, smokes when struck by the solar ray, and breathes herself out into the neighbouring aether.*

Lastly, you will understand clearly what the excellent Boulliau decides on this matter from his letter to me, dated at Paris [Lutetiæ] on 1662 August 3. I have chosen to append it in this place for this reason: because it brings no small light and weight to this question, namely that lunar exhalations and evaporations exist.

[Margin: Literæ Celeb. Bullialdi ad Autorem.] *The letter of the celebrated Boulliau to the author.*

Most honoured Sir: in my last letters I sent you old astronomical notes; but it slipped my memory then to add at the same time an observation I made concerning the Moon, which, if still others are added to it, seems sufficient to prove that vapours emitted by that planet spread around its body. This observation, which I send to You, was made carefully by me, and with the greatest attention of eyes and mind; I set myself against every preconceived opinion, and avoided the deceptions by which our air could have drawn me into error. Receive, then, the very words that I wrote at that time in the papers of my observations.

[Margin: Inſignis obſervatio Bullialdi; dari vapores circaLunam.] *A notable observation of Boulliau's: that vapours exist around the Moon.*

In the year 1659, on Thursday [die Jovis], March 27, at about 8^h *after noon, I examined the Moon with a spyglass or optical tube. It was moving towards the rays of the Sun [ad Stell. radios Solis] [?], and occupied,* n. *[?], about 2° of Gemini. The sky was very clear and purified, and through the tube the smallest stars could be seen, which cannot be discerned with the naked eyes. In the part of the Moon that receives light from the earth and shines by it, I noted dense mists, so that part of the eastern disc was seen only with the greatest difficulty, the northern part [pars v. Borea] [?] a little more clearly; but the southern part, although it too was surrounded by mists, appeared clearer and brighter than the rest.*

[Margin: Nebulæ Lunares.] *Lunar mists.*

We cannot say and determine that those mists hung in our air that surrounds the earth, for they would have taken away the sight of the stars of the third and fourth magnitude. Those vapours must therefore have been emitted from the very body of the Moon. I noted again, for a short space of time, that the Moon was surrounded by those vapours, shining with a tawny and golden colour, with which coronae do not usually shine. This phenomenon [was] seen at Paris.

I remember that you told me something similar had been observed by you when I was staying as a guest in your house. From these twin observations, and from others to be made hereafter, it will be established that vapours and exhalations are emitted from the lunar body, and from the terrestrial one, and spread around its surface. From this, much profit will flow over to physics and optics. Very many authors agree with this opinion; so that time may be spared, I gladly refrain from listing them here.

[Margin: An circa reliquos Planetas etiam detur Orbis vaporoſus.] *Whether there is a vaporous orb around the other planets too.*

From here I now turn to inquiring whether around the other planets too, the superior as well as the inferior, there exists a vaporous sphere, as there does around the Sun and the Moon. Indeed, just as all the bodies, wandering and fixed alike, agree entirely with the Sun, the Moon and the Earth in this, that they likewise are not perfectly spherical, not at all smooth, but extremely full of hollows, uneven, rough and broken, and also of differing density and opacity (as is sufficiently admitted from the overall light they cast to us, and as we set out to prove clearly in Chapter 6, p. 133 of the *Selenographia*), and especially since they display very diverse colours, and various spots and shadows, and changeable ones at that, as anyone can readily see in Jupiter: it is certainly necessary that the other planets, too, no less consist of purely heterogeneous parts, and are mixed bodies, of the same nature as the Sun, the Moon and our earth; or, what is the same, that they are necessarily subject to generation and corruption, as to their exterior parts only, I say; and consequently that they also breathe out and cast forth expirations, vapours and the effluvia of breaths.

[Margin: Planetæ omnes conſtãt ex partibus heterogeneis,ac generationi&corruptioni,quoad partes, ſunt obnoxii.] *All the planets consist of heterogeneous parts, and are subject to generation and corruption as to their parts.*

There is the further point that all the bodies of the world, together with the Sun and the Moon, dwell in one and the same medium, namely the aether, which is endowed everywhere with the same transparency, subtlety and essence, as has already been said several times. Because of this it is altogether necessary that generations and corruptions also occur around all the aethereal bodies.

But, you will say, why are alterations and changes of this kind not equally evident and detectable in those smaller planets and in the fixed stars, as they are in each of the two greater luminaries [in utroq; luminare majori]? Plainly because the excessive distance of those bodies from the earth, the smallness of their apparent diameters and the weakness of our sight (even if it is helped by any telescope, however excellent) do not allow us to reach the point at which we could see all those things, and any of the smallest alterations, however much they may occur there, and detect them distinctly.

[Margin: Cur non æq́; in reliquis Planetis ac in Sole &Lunâ alterationes cuivis ſint obviæ.] *Why alterations are not as plain to anyone in the other planets as in the Sun and the Moon.*

What, I ask, do you think? If it were permitted to contemplate our earth from the fixed stars, or even only from the Moon, as the body nearest to us of

all the aethereal ones, an earth on which so many and such great generations, corruptions and transmutations occur daily, do you suppose that we could then detect all of them, each and every one, distinctly? Not at all, certainly; indeed hardly anything more would come into our view from the earth than [does] in the other bodies. Except that to us, dwelling on the Moon, or to the Selenites, only various spots and shadows would be seen around the earth (which would appear under a notable diameter of almost two degrees). These, no differently from the solar ones, would not rarely be seen to be generated there, namely in the earthly atmosphere, and to be altered, increased, diminished, and in their time, in turn, dispersed and destroyed.

[Margin: In Terrâ ex Lunâ conſpectâ pariter ut in Sole maculæ & umbræ obſervantur.] *In the Earth seen from the Moon, spots and shadows are observed just as in the Sun.*

This, however, with an express distinction: since the earth revolves entirely about its axis continually in the space of twenty-four hours, but the Sun only in each period of twenty-seven days, the terrestrial spots would from this be observed to go out completely, as it were, from the earth's disc in the space of twelve hours; whereas this usually happens to the larger and more solid spots of the Sun after an interval of 12 or 13 days.

[Margin: Maculæ Terreſtres ſæpiùs diſcum Terræ peragrare videntur.] *The terrestrial spots appear to travel across the Earth's disc more often.*

But again, just as these solar [spots] very rarely return, that is, only very seldom rise again on the Sun after twelve or thirteen days have elapsed, and its disc a second time, let alone a third, travel across; so those terrestrial spots (namely our clouds, vapours and exhalations) would very often present themselves afresh on the following day, almost in the same place where they had stood on the day before, especially if certain denser and thicker clouds were lingering over some particular horizon. Indeed, they would be visible on as many occasions and days as those clouds stayed unmoved here with us.

[Margin: Vicisſitudines Macularum Terreſtrium ex Lunâ conſpectarum.] *Vicissitudes of the terrestrial spots seen from the Moon.*

Moreover, these clouds of ours, just like the solar spots, would be transformed, condensed and dispersed in various ways. They would differ, however, in this: these terrestrial spots would not be continually visible to the Selenites, even if they were really there, because the earth, with respect to the Moon, continually shows phases that wax alike and wane alike, so that spots lying in the dark part of the earth would in no way be seen. But these vicissitudes would be noted best of all at the time of the opposition of the Sun and the earth, that is, at the time of Full Earth [Pleniterrei], when the whole disc of the earth is fully illuminated.

But if it fell to us to view these spots from the Sun, believe me, they would come into view every day for as long as they lasted; on this condition, however, that at all times they would appear whitish and shining white, as if they were

the brightest faculae, just as the solar spots for the most part [appear] blackish and darker.

[Margin: Maculæ terreſtres ex Sole viſæ ſemper albicantcs & lucidisſimæ apparent.] *Terrestrial spots seen from the Sun always appear whitish and very bright.*

The reason is this: these terrestrial spots, with respect to one standing on the Sun, are steeped in the Sun's light on the side turned towards it, so that they must necessarily appear very bright and whitish. The solar spots, by contrast, being opaque bodies, are always illuminated on the side turned away from us, and only the dark part of the spots, the part turned away from the Sun, falls under our sight. Hence these [solar spots] appear blackish and dark, but those [terrestrial ones] shining white and bright.

Next, it would be a pleasant sight that in some parts of the earth, namely in Egypt and Arabia, on the shores of both Indies, and in other [places] where it rains very seldom, spots would also be generated only very rarely; whereas in other districts of the earth, such as Europe and more northerly places, [they would be generated] extremely often.

Lastly, the solar spots constantly keep to a certain zodiac, as it were, of about 50 and 60 degrees, namely around the middle of the two poles, in which the generations of the principal spots take place; but the terrestrial spots would always be more frequent in the temperate zones, towards either pole, than under the equator, that is, in the torrid zone, since in these regions the air is at all times far purer than in those. Very many other things of this kind would meet our eyes if we were on the Moon and on the Sun, and it would be easy to add them here as well, if we wished to go further; but so as not to seem to digress too far from our aim, let us return to our purpose.

[Margin: Quâ in Terræ parte frequentiores darentur maculæ, ſi ex Sole, vel Lunâ obſervarentur.] *In what part of the Earth spots would be more frequent, if they were observed from the Sun or the Moon.*

These terrestrial generations and changes alone, I say, are what we would detect, and that only from the Moon; for from the other aethereal bodies not even these, nor anything of this kind, could be noticed in any way. For the apparent diameter of the earth, viewed from Saturn, Jupiter, Mars, Venus and Mercury as well as from the Sun, would be of very small size, even though these bodies are at their nearest distance, as is plain to anyone from the little table attached, with Kepler's distances of the planets taken as given.

[Margin: Præter Macularum phænomena nihil in terrâ, ex Sole &Lunâ deprehendi poteſt; ex reliquis verò Planetis penitùs nihil.] *Apart from the phenomena of the spots, nothing on the earth can be detected from the Sun and the Moon; but from the other planets, nothing at all.*

Apparent diameter of the Earth, seen from	Deg.	′	″	‴
the Moon	2	7	22	0
Venus		7	58	34
Mars		5	32	8

Apparent diameter of the Earth, seen from	Deg.	′	″	‴
Mercury		3	56	8
the Sun		2	3	16
Jupiter			50	48
Saturn			15	20

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[Margin: Quanta foret diameter apparens terræ ex Planetis conſpecta.] *How great the apparent diameter of the earth would be, seen from the planets.*

Therefore the Earth, seen from Venus, appears only twice as large as Venus herself at perigee; from Mars, scarcely a little larger than Venus at perigee; from Mercury, smaller still than Venus; from Jupiter, almost equal to Jupiter; and from Saturn it would show roughly the size of Spica or Arcturus, provided, that is, that the true diameters of the planets and of the fixed stars are taken into account.

Since, then, it is certain that the earth, seen from the other planets (if you except the Moon), would appear very small, so that these generations, changes and corruptions, which occur in abundance both around and on the earth, could in no way be detected, why then do you wonder, candid reader, that changes and vicissitudes of this kind in the other planets, or in the fixed stars, are so imperceptible?

[Margin: Sicut ex cæteris Planetis generationes & vicisſitudines terreſtres,ſic pariter ex terrâ eædem nullo prorsùs modo percipiuntur.] *As with the terrestrial generations and vicissitudes seen from the other planets, so likewise from the earth the same are perceived in no way at all.*

Nevertheless, let us show clearly that around Jupiter itself too, so far removed from the earth, there exists a vaporous sphere, and continual exhalations that can be plainly noticed. And first, I think hardly anyone is any longer unaware that four companions around Jupiter were discovered by Galileo the Lincean [à Lynceo Galilæo], namely those Medicean stars. Each of them performs its own particular motion around Jupiter as its centre, in its own orbit, and completes it in a fixed period.

[Margin: De atmoſphærâ Jovis, ejusq́; Comitibus.] *On the atmosphere of Jupiter and its companions.*

Hence it happens that they are now more, now less distant from Jupiter, namely along a straight line on either side [of it]; and indeed that at their farther remove from Jupiter they appear much smaller than at the nearer one, that is, when they are closest to Jupiter. Yet at every time and in whatever position these companions ought by rights to appear to us always of the same

546 On the page this small ruled table stands at the head of the leaf, to the left of the paragraph beginning "Therefore the Earth, seen from Venus", with the side-note beside it on the left. Its head runs over two lines, "Diameter apparens Terræ" across the whole table and "conſpecta ex" over the names, and the four columns of figures are headed "Gr.", "Min.", "Sec." and "Tert." (degrees, minutes, seconds and thirds). Blank cells are blank on the page.

size, not to say somewhat larger still at a greater elongation from Jupiter than at a smaller one, because of Jupiter's brightness, which obscures and diminishes them more when they are in its vicinity. For, according to that well-worn optical axiom, the greater light obscures the lesser. Nonetheless, the contrary has been observed more often by Galileo (as can be learned from the *Sidereus Nuncius* [Nuncio Sydereo]) than by us.

[Margin: Cur Jovis Satellites nonnunquam majores appareant.] *Why Jupiter's satellites sometimes appear larger.*

This phenomenon, however, certainly does not arise in any way from a greater distance of the companions from the earth. For those apparent orbits in which they are carried around are very narrow and compressed: the greatest of them hardly runs out to a few minutes in diameter, so that with respect to us they are of no account at all. Nor can the reason be sought in our atmosphere; for otherwise they would always be seen at exactly the same size. Nor in some refraction of the aether: for the aether, as is clearly established from optics, is entirely without any refraction. Therefore, as far as I judge, quite another cause lies hidden beneath, one closer to Jupiter; and none remains but that we establish that there is likewise a vaporous orb around Jupiter. When those companions of Jupiter, or Jovials [Ioviales], enter it, they must, by reason of refraction and of matter a little denser than the rest of the aether, always appear somewhat larger than when they stand outside that atmosphere in the purest aether.

[Margin: Æther refractione omninò caret.] *The aether is entirely without refraction.*

Moreover, sound reason keeps telling us that this Jovial atmosphere can further, both from the zones or bands and from some other spots, by the help of the tele- [Margin: De maculis[[,/;]] Zonis, ſeu f[[a/á]]ſciis certo tempore in corpore Joviali obviis.] *On the spots, zones or bands met with at certain times on the Jovian body.*

scopes not so long ago detected on Jupiter, and partly sketched in the *Selenographia* [Selenog.], p. 42, be fittingly corroborated; indeed, [it tells us] that there is there not only a sphere of exhalations, but that likewise, just as there are clouds around the earth and spots around the Sun, so in Jupiter too there exist certain evaporations and effluvia, according to laws prescribed for them by nature, as well as generations and corruptions. For these zones and spots are not always constant at every time, nor do they keep a similar appearance perpetually: sometimes they are seen scattered over the whole disc, sometimes again in the form of rather oblong zones. Moreover, they agree neither in number nor in form: now a single band appears, equally broad and extended; now two of this kind; now others tapering to a point at both ends, as I remember having observed them several times in the year 1648, on February 19.

[Margin: MaculæJoviales ſunt nubes & evaporationes,diverſæ tamen naturæ à noſtris terrenis] *The Jovian spots are clouds and evaporations, yet of a different nature from our terrestrial ones*

Now these bands and spots visible on Jupiter are, as far as can yet be gathered, clouds, shadows and exhalations, like our clouds and the solar spots; except that they differ in this, that compared with these they are of a different nature, since they seem to be more durable and more constant than our clouds and the solar spots. For these are consumed and dissipated within a short space of time, after a few days have elapsed; but the Jovian ones stay in vigour for some months and more, and are preserved constantly in almost the same appearance before they change or vanish entirely.

[Margin: Cur maculæ Jovis ſemper ut Terreſtres ſint albicantes ?] *Why are the spots of Jupiter always whitish, like terrestrial ones?*

Again, they agree with our clouds in this: they likewise appear whitish and somewhat pale, but by no means blackish, as the solar spots do. That is, because the Jovian spots always turn the same part of their body towards both us and the Sun, no differently from terrestrial clouds when they are viewed from the Sun. From this it is conjectured, not without reason, that the Jovian spots and zones are evaporations and exhalations ejected and breathed out from the Jovian body into the atmosphere.

[Margin: Corpora ætherea volvuntur circa axem.] *The ethereal bodies turn about an axis.*

Unless we would rather establish that these vicissitudes and variations of the spots take their origin from a gyratory motion about an axis. This motion, it is true, even if it is indeed common to all the planets and even to the fixed stars themselves, as will be shown below; nevertheless, since various difficulties attend this opinion, I therefore prefer the former [opinion] for the time being, until more certain things are found out about this phenomenon and about the fixed period of all its vicissitudes.

[Margin: Vniverſos globos cœleſtes orbem habent vaporoſum.] *All the celestial globes have a vaporous orb.*

And so it is by no means absurd, in my opinion, that each of the celestial globes too, like the Sun, the Prince of the ethereal bodies, should continually breathe out and emit exhalations and effluvia of vapours, which make up a vaporous orb. The following reason further recommends this: that four different smaller planets go around Jupiter, as you have learned, and another, recently detected, around Saturn, in a fixed interval of time, just as if they were certain Moons, imitating ours.

[Margin: Comites Jovis & Saturni ſunt inſtar Lunarũ, maximasq́; exerunt vires in commovendis extrudendisq́; exhalationibus.] *The companions of Jupiter and Saturn are like moons, and exert very great forces in stirring up and driving out exhalations.*

For just as each of the two luminaries has no common power to act on these lower things, and to stir and alter especially the sublunary humours and vapours, so, certainly, I have no doubt that these smaller planets too, with all the other [bodies] assisting, especially the Sun and the fixed stars, by virtue of the various aspects which they form with one another, and of the motion of

circumrotation, as well as of a certain natural faculty implanted in these vapours, exert great forces upon Jupiter and Saturn in

[Margin: Anſulæ Saturni quantæ ſint magnitudinis.] *How great the little handles of Saturn are.*

stirring up, expelling and driving out effluvia of various kinds. And this all the more in Saturn, because it is never without its escort of two half-moons, as it were, clinging closely to its body. These are of such bulk that a single half-moon not only comes close to the size of our Moon, but exceeds it almost one hundred and ninety times.

[Margin: Natura otioſa & ſuperflua abominatur.] *Nature abhors what is idle and superfluous.*

For nothing indeed is more certain than that God created nothing whatever in vain, and that nature abhors everything idle. And although I do not altogether deny that those Jovian companions, together with that Saturnian [companion] and the attendants [lateronibus], also exert their powers as far as this earth, yet I think they extend their forces far more strongly to those nearer, adjacent bodies. For by reason of their size and nearness they are very considerable to those bodies; but to us, because of the immense distance by which they are removed from the earth, they come into view in no way unless we are equipped with the best telescopes [Tuboſpicillis].

[Margin: Corpora ætherea univerſa reciprocum patiuntur influxum ſuo modo.] *All the ethereal bodies undergo a reciprocal influx in their own way.*

For just as all the planets and fixed stars act on these lower things, so the Sun and all the other planets, together with all the fixed stars, also undergo a reciprocal influx from the ethereal bodies around them, according to the character of their own power. This power of stirring up and ejecting vapours in those companions, or rather little moons, of Jupiter and Saturn is aroused the more vehemently, the more swiftly they pursue their motion around Jupiter and Saturn.

[Margin: Saturni & Jovis Lunæ,longè velociores ſunt noſtrâ Lunâ.] *The moons of Saturn and Jupiter are far swifter than our Moon.*

For all of them, however many there are, are far swifter in their course than our Moon. The period which the Moon completes in the space of about a month, the First of the Jovials, namely, completes in the space of sixteen days; the Second in seven; the Third in three; but the Fourth and last in one and a half days. Likewise that new Saturnian, as if a rival of that First in the order of the Jovials, also completes its course in almost sixteen days; so that each of the two, the slowest, is carried around Jupiter and Saturn almost twice as fast as our Moon around the Earth. I do not see, therefore, why you should not attribute to these little moons, or wandering stars, their own effects and operations upon the same similar matter too, in like manner as to our Moon.

[Margin: An Mars, Venus & Mercurius nullas foveant aſſeclas ?] *Do Mars, Venus and Mercury keep no attendants?*

But whether several little moons and wanderers of this kind exist around Mars, Venus and Mercury too, I am altogether in doubt. It is clear, indeed, that none at all have been detected so far, that is, with our telescopes worked to a spherical section. But if lenses of hyperbolic section are brought to absolute perfection, as is indeed possible (even by us specimens of no common kind can already be shown to anyone, made by an entirely new, singular and very easy method, which, if it so pleases God, we intend to treat expressly at another time), then certainly, without any doubt, a great many things hitherto unknown will be discovered in the other, inferior planets too, and brought to light. But enough of this.

[Margin: An circa inferiores Planetas orbis vaporoſus deprehendi poſſit ?] *Can a vaporous orb be detected around the inferior planets?*

It follows that I should still add in a few [words] (before we come to the fixed stars) and inquire whether around Venus too, as has indeed been the case with the superior planets, some trace of an atmosphere can be noted. But when I weigh this matter more carefully with myself, I see that it is most probable that a certain vaporous orb surrounds the globe of Venus, no less than it surrounds the Sun and the Moon.

[Margin: Venus Colorem, magnitudinem & figuram quondam mutavit.] *Venus once changed her colour, size and shape.*

For Venus at one time changed her colour, size and shape completely, as St Augustine [D. Auguſtinus] noted in *De Civitate Dei* [de Civit. D E I] from the records of Marcus Varro [Marci Varronis]: *In the heavens a wonderful portent appeared* (so run the wor- ds of Varro) *that the star of Venus (which Plautus calls Vesperugo [Veſperuginem], Homer Hesperus) changed its colour, size, shape and course: a thing that had happened in this way neither before nor since. Adrastus of Cyzicus [Adraſtus CyZicenus] and Dion of Neapolis [Dion Neopolites], noble mathematicians, said that this happened in the reign of King Ogyges.*

[Margin: Quænam illius phænomeni genuina ſit ratio.] *What the genuine explanation of that phenomenon is.*

If we inquire into the physical causes of this unusual event, only three are at hand: either [it lies] in our atmosphere and in terrestrial exhalations; or it really occurred in Venus herself, and she thus suffered some diminution and loss of her body; or it is to be referred solely to some denser matter lying very close to Venus. As for the first explanation, who does not see that it can by no means be proved? The second, too, hardly anyone will grant, and then not easily, unless under the utmost compulsion. What, then, I ask, remains, but that we take refuge once again in the atmosphere of Venus? By means of it all these phenomena, as you understand without my saying so, are explained and demonstrated with almost no trouble.

[Margin: Etiam ipſæ Fixæ evaporationes, & exhalationes exſpirant.] *The fixed stars themselves too breathe out evaporations and exhalations.*

Finally, that alterations and changes also occur around the fixed stars themselves (which all enjoy native light, and no borrowed light at all, as the planets

indeed do), especially by reason of the evaporations and exhalations which they continually breathe out and emit, is inferred from certain arguments that are by no means obscure. And first, indeed, from their twinkling and the agitation of their light.

[Margin: Cur Fixæ ſcintillent ?] *Why do the fixed stars twinkle?*

I am not altogether unaware, it is true, that philosophers have given various causes for this twinkling. Some ascribe it to the size and brightness of the body; others to the motion of the star and to the motion of the light in the star itself; others to distance and to the weakness of our sight; others to the daily motion of the earth, or the primum mobile, and to the intervening medium, or our atmosphere; others again solely to the circumgyration of the stars. Yet if these are weighed exactly, they are not the genuine causes of twinkling, as it is not difficult to show by many [arguments], if we wished to dwell on them longer. All the same, I do not deny that among the causes named some are found that assist, especially the last, namely the circumgyration; but neither these, nor others, even if they contribute somewhat to this matter, suffice on their own.

[Margin: Omnia corpor[[a/á]] ætherea perfecta ſuper axem rotantur.] *All perfect ethereal bodies rotate about an axis.*

It is indeed beyond doubt, just as I too hold it firmly, that all the stars, both the fixed stars and the planets, the Moon excepted, rotate continually about their own axis. Nonetheless, since those very vast ethereal bodies are not, as far as I judge, carried round with so swift and rapid a gyratory motion, the twinkling in no way depends on it.

[Margin: An corpora univerſa æq; velociter circumgyrentur?] *Do all bodies rotate equally fast?*

For, as it seems, the greater the interval by which celestial bodies are removed from us, the slower the motion of circumgyration with which they are endowed. Thus the Earth turns round once every day; the Sun about once every month; but Jupiter, as far as can so far be gathered from its spots, in a much longer space of time; so that the remaining bodies, especially the far more remote ones of the fixed stars, without doubt move about their axis more slowly still.

[Margin: Vera ſcintillationis,ſeu corruſcationis cauſſa.] *The true cause of twinkling, or flashing.*

This, therefore, is not the sole and only reason why the stars flash and twinkle; rather, we judge that another lies hidden alongside it. Namely, the vibrating-out of luminous matter and the continual expiration of vapours and exhalations, which is innate in those bodies (no differently than in the Sun, the Moon and the Earth, though according to their own nature and constitution), is the principal cause of this twinkling. For the more dense and compact this or that body is by nature, or the more rare (since, indeed, in all the ethereal bodies there is not the same mat- ter density), the thicker or the thinner are the exhalations it emits and ejects. And the thicker the effluvia the stars emit, and the greater the quantity, the more vehement and the more conspicuous the twinkling they display.

[Margin: Nova aſtra nonnunquam in æthere exoriuntur rursùsq́ue occidunt.] *New stars sometimes arise in the aether, and set again.*

Finally, great weight is also added to this view of ours by the new stars, which are not only generated in the heavens themselves, among the eternal bodies, but also at times perish again and are dissolved. This has happened with most of them; though of these, some are still seen even now in the highest aether.

[Margin: Stellæ novæ, creſcunt & decreſcunt, colorem lumenq́; diverſimodè mutant.] *New stars wax and wane, and change their colour and light in various ways.*

But all that have ever appeared, however many, were of such a nature that they waxed, waned, and changed in various ways, as much in colour and in the brightness of their light as in size.

[Margin: Stella Polaris aliquando evanuit.] *The Pole Star once vanished.*

Again, others, even among those old fixed stars that have shone continuously on the world for many centuries past, have been entirely extinguished, so that they could no longer be found. For it is reported that after the capture of Byzantium the Pole Star was no longer seen: Gemma Frisius, Book I, Chapter VIII, p. 212, *Cosmocrit.* Then Hyginus, chapter 192, writes that one of the Pleiades, Electra by name, vanished from sight at the time of the destruction of Troy, and that she spreads out her loosened hair in mourning.

[Margin: Nonnullæ Stellæ lucidiores extiterunt.] *Some stars have become brighter.*

Conversely, other stars have become more splendid and brighter, as the author mentioned before reports in the same chapter cited: *Indeed, most* (he says) *[hold that] in the year 1572 and the following the stars in the foot of Orion and in the wing of Corvus were made much brighter and more splendid.* Although these things do not seem altogether absurd to me, yet with most people they will hardly find belief. For this reason I shall adduce other, more recent [cases], and indeed ones beyond all objection, which can certainly never be called into doubt by anyone, unless he is plainly out of his mind, or wishes from an obstinate spirit to fight against the most manifest truth; for almost all the historians of that same time, not to say the astronomers, testify to them unanimously.

[Margin: De novo Sidere in Casſiopeâ anno 1572 exorto.] *On the new star that arose in Cassiopeia in the year 1572.*

First, namely, that in the year 1572, in the month of November, a quite newly risen, or adventitious, star, never seen in the heavens before, appeared in the constellation of Cassiopeia. About it, above all, Tycho Brahe, that incomparable searcher of the stars, and also the most learned Cornelius Gemma, to say nothing of others, have reported a great deal. But so that I may add here only the chief points, which seem to bear on this business of ours, you should know that this very star at first, that is, throughout the whole month of November, surpassed in size all the other stars, both Lyra and Sirius, and even Jupiter itself at its acronychal rising [acronychium]; and that it came as close as

possible to the torch of Venus, when Venus is nearer to the Earth and shines with a fuller face, so that it was seen distinctly even by day, at noon itself.

[Margin: Ejus magnitudo ac claritas, non perpetuò fuit eadem.] *Its size and brightness were not always the same.*

This remarkable size, however, it did not keep throughout its whole duration, but decreased little by little until it ceased to exist altogether. For in the month of December it was almost equal to Jupiter, and somewhat larger than the stars of the first rank, and in February and March it shone somewhat smaller. Thus in April and May it resembled a star of the second magnitude; then it became successively smaller and smaller, so that towards the end of the year it barely resembled a little star of the fifth magnitude, and in the following March it was nowhere to be seen any longer.

[Margin: Quomodo colorem ſucceſſivè mutaverit.] *How it changed its colour successively.*

In the same way, moreover, it did not show a similar light and colour at all times: at the beginning it was seen with a whitish, clear and shining light, with a pleasing and delightful face; afterwards this shining radiance changed its colour into a certain yellowish one, and around the beginning of the spring of the following year into an altogether ruddy one, like Aldebaran; then it took on a slightly livid whiteness, especially around the end of May, and around the end of its apparition an altogether dull and turbid colour, as Tycho noted at length in Book I of the *Progymnasmata*, Part II, Chapter III, p. 301. He adds, on p. 303:

[Margin: Tychonis annotationes de hâc Stellâ anni 1572.] *Tycho's notes on this star of the year 1572.*

This was the appearance and outward condition of the unusual star with respect to the circumstances of its form, size, light and colour, and to their alterations, carefully considered over the whole time of its duration. For although the condition of the air, which in the meantime was sometimes of various kinds and not always uniformly clear, may now and then have presented something in each of these a little differently to the eyes, and this also according to the differing sharpness of sight of those observing, yet this was rather accidental and did not last long. Hence the things we have recorded are not to be judged as coming from some momentary and quickly passing aberration of sight, owing to some hindrance in the medium; but since they were detected in this way by observation repeated long and often while the air was clearer, and compared with one another, no doubt remains that they are correct. Almost the same, but in other words, can be read in the said Cornelius Gemma, Book II, *Cosmocrit.*, Chapter III, p. 123.

[Margin: Nova Stella in pede Serpentarii, qu[[â/á]] ratione etiam aucta & diminuta fuerit.] *The new star in the foot of Serpentarius, and in what way it also increased and diminished.*

Second, not much inferior to this adventitious star of Cassiopeia was the one that many most learned men observed, with great admiration indeed, in the foot of Serpentarius in the year 1604, in the month of October — above

all Kepler, who published a separate little book about it. At first it fell short of the other [star], that of the year 1572, by only a very little in size, and in light and colour as well. *For the reports of almost everyone agree* (says Kepler, p. 6 of the book on the new star) *on the first magnitude: that it appeared larger not only than the stars of the first rank, but also than Saturn, Mars, and Jupiter, which stood near it the whole of October, and which, by the friendly and gentle calm of its light, was easy to distinguish from the turbulence of the star with its flashing.* This star, however, just like that one of Cassiopeia, was afterwards gradually much diminished from that former size: for in the month of January of the following year, 1605, it was hardly equal to Saturn and Arcturus, and in the month of March hardly equal to those stars of the third rank in the knees of Ophiuchus; and so, from day to day up to the month of October, it decreased more and more, until it was entirely extinguished.

[Margin: DeStellâ adſcititiâ in pectore Cygni.] *On the adventitious star in the breast of Cygnus.*

By contrast, another new [star], in the breast of Cygnus, recently born in the year 1600, still presents itself to be seen. At first the star appeared to be of the third rank, somewhat smaller than the one in the breast. As to this size: although I have measured it quite often with instruments, yet I remember that I almost never found it much smaller than [it was when] Kepler first observed it. For he asserts in his little book on the same star, p. 166, that it always kept the same size: it never equalled its neighbour in the breast of Cygnus, namely the old one, but neither was it ever so diminished that it seemed equal to the one in the Beak of Cygnus; and as to colour, it was always seen with a constant and pale [one].

[Margin: Anno 1660 dicta Stella incepit decreſcere.] *In the year 1660 the said star began to decrease.*

With an almost similar appearance too, as we were just saying, we surveyed it at all times up to the year 1660, so that it was always somewhat smaller than the one in the breast, yet equal to the one at the tip of the wing, but with a light a little ruddier and duller. From this, certainly, one may gather that from the year 1600 up to now it has decreased very little indeed. But look: recently, when once again, to observe the stars in Cygnus, I prepared myself — namely on 1660 October 24 — I found, not without great amazement indeed, with the sky very clear, that this new [star], called Antepectus, was much diminished, both in size and in brightness. For when, with fixed eyes, I examined it continuously for some hours together with a certain friend, we found that it was now altogether far smaller: not only than the one in the beak of Cygnus (than which, on Kepler's testimony, it was formerly larger), but also than the one at the tip of the wing; indeed, that it was still a little smaller than the one of the fifth magnitude in the Neck; that it was hardly equal to that one, namely the southern preceding one of the unformed [stars] before the southern wing of Cygnus; and that, no less, it had a far duller light and colour than at an earlier time. But what will happen next — whether it will decrease successively

more and more, or will instead recover its former size again? Time will tell; and for this phenomenon I promise always to be a watchful observer.

[Margin: De admirando novo Sidere in collo Ceti.] *On the wonderful new star in the neck of Cetus.*

But what need is there to recount at such length those things that either existed long ago or have even now entirely vanished, when another phenomenon, wholly new or adventitious, is at hand in the aether itself, one that strikes the eyes of all? Certainly nothing of this kind has ever existed since the founding of the world, at least so far as has been handed down to memory: one that, among the fixed stars themselves, which are coeval [with it], undergoes such various vicissitudes. For that star shines for some time with rays flashing most splendidly on all sides; at a certain time it grows; again it decreases; then it even vanishes altogether and stays hidden for some months; afterwards, in turn, it presents itself again, returned — and indeed always in the same place where it had been seen before — and it holds a place so fixed among the other fixed stars that no parallax at all is detected. It deserves, therefore, that I repeat the history of this wonderful and quite unusual star somewhat more accurately, but still briefly (since we have already treated it expressly and more broadly in a separate little book published in the year 1662).

[Margin: Annotationes Phocylidis de hâc nov[[â/à]] Stellâ in collo Ceti.] *Phocylides's notes on this new star in the neck of Cetus.*

I do not doubt, moreover, that it is not unknown, if not to all, then at least to many of the learned — those who do not always cling to the ground, but at times also raise their minds and eyes on high — what has happened in recent years in the heavens themselves: namely, that Johannes Phocylides, that far from common philosopher and astronomer, in the year 1638, at the beginning of the month of December, on the occasion of a lunar eclipse, noticed a new fixed star, newly risen in the constellation Cetus, and indeed in its neck. He also set down a separate little book about it, where among other things, on p. 197, the following is read about its size: *Finally* (he says) *its size, both to the naked eye and through the telescope, was such as to exceed the stars of the third brightness, such as are those in the mouth and cheek of Cetus, and also the Knot of the Fishes; but it was also perceptibly smaller than the stars of the second magnitude, namely the jaw and the bright one in the Head of Aries.*

[Margin: Stella hæc miras ſubit vicisſitudines.] *This star undergoes wonderful vicissitudes.*

Meanwhile it decreased gradually, and step by step, until at its heliacal setting it was equal to stars of about the fourth rank and magnitude. He adds, moreover, on p. 285: *Note that we have ascribed a disappearance to this new phenomenon observed by us. See p. 197. And indeed that is how the matter stands. In midsummer we rose several times very early in the morning, after it would otherwise have risen heliacally; we surveyed the sky most diligently with intent eyes; we saw the Knot, the Mouth, the Cheek, the Jaw of Cetus, and the other neighbouring stars round about; no trace*

of the new star could then be observed. Nor I was the only observer; several suitable witnesses [were] with me;

[Margin: Fullenii Obſervationes.] *Fullenius's observations.*

indeed, the most distinguished man Bernardus Fullenius, professor of mathematics, also searched for the phenomenon many times. All in vain. A sure sign that it had, as it were, disappeared. But on 1639 November 7, in the Julian year then running, after continuous clouds with us for some days, indeed weeks, when the sky was at last clear in the evening, I happened to go out and observed it — and anyone is still free to observe it — in precisely the same place, in the same position as before.

[Margin: Nova Stella in colloCeti creſcit & decreſcit, nonnunquam etiam penitùs evaneſcit.] *The new star in the neck of Cetus grows and decreases, and sometimes even vanishes entirely.*

From this, therefore, you understand well that this new star vanished in the year 1638 and appeared again in the following year, in the month of November, and indeed in exactly the same place among the fixed stars themselves where it had shone before. Fullenius, professor of mathematics at the Academy of Franeker, also found this to be so many times: namely, that this star strictly kept to its vicissitudes, sometimes being present in the sky, sometimes entirely hidden. About it the same author wrote the following to a friend in the year 1644, in the month of September: *Some years ago* (he says) *I observed in the sky a phenomenon like a star, mostly of the third magnitude, which, however, according to the seasons of the year not only changed its size but also at times stayed hidden for days, indeed months — as also this year, when up to this day it has not yet appeared; and this also happened two years back, when it could not be seen before September 23.*

[Margin: D.Jungii Obſervatio.] *D. Jungius's observation.*

This star of Cetus was likewise seen by D. Joachimus Jungius [Joachim Jungius], professor and rector of the Hamburg Gymnasium, in the year 1647, on February 18 and 20, up to its heliacal setting; *but from then on* (as he wrote to D. Eichstadius) *although carefully sought by me from the month of July, it has not yet appeared.*

[Margin: Autoris Obſervationes.] *The author's observations.*

Again, in the year 1648, on January 5, I remember that I too observed it: larger, indeed, than the Knot of the Line and the one in the mouth of Cetus, yet smaller at that time than the Jaw, as I noted in my notebooks [Adverſariis]. From that time, however, I confess that I observed it only rarely; for, distracted by other business and studies, I almost forgot it, thinking that it had by now perished altogether. So too in the year 1659, in the month of August, while it was being carefully searched for by me and Dn. M. Kretzschmer, not a trace of it was detected. But on December 14 of the same year, at 9^h in the evening, I saw it very well together with my mechanician [automaturgo], who at that time was assisting me with observations, and I also observed it accurately with our great brass sextant: it was found to be larger than the one at the cheek of Cetus, of the fourth magnitude, yet smaller than the one in the mouth of Cetus, of the third magnitude; its colour was somewhat gloomier. From that very day it

decreased gradually up to its heliacal setting. When I had noticed this, and had also called to mind what is recorded above, I resolved firmly that I must watch it more diligently in future, so that I might find out properly whether everything would happen in that way again in the following year, 1660. Accordingly, as soon as Cetus had risen heliacally in that year, on every clear night, whenever observations were being carried out, I searched anxiously for that star, together with certain others who were then at my side; but nowhere, believe me, did it appear, as if it had never existed in the nature of things. Indeed, not even the least sign of it was detected with the optical tube, namely from the beginning of the month of July up to the beginning of September; except that on the first and second of the same month, as it were a very tiny star, like [one] of the sixth or seventh magnitude, it seemed to be present in the very place where it used to appear. From the second day, however, up to September 10, the sky was entirely cloudy, so that nothing was observed by us. But on September 10, when, as is my custom, I was again contemplating it, look: it was seen quite clearly, like a little star of the fourth magnitude, hardly smaller than the one at the cheek of Cetus; with this [star] and the Jaw it always forms a straight line, so that on that same night I measured it very well from various stars. Its colour [was] somewhat ruddy and dull; in light and brightness it appeared much inferior to the Jaw.

[Margin: Colorem non ſemper eundem præ ſe fert.] *It does not always show the same colour.*

After this it grew perceptibly from day to day: for on September 18 and 20 it had already reached the size of the one in the mouth of Cetus; on the 27th, 29th and 30th it was larger than the one in the mouth of Cetus; on October 10 and 13 it seemed equal to the Jaw, but surpassed it in brightness, and in its light it appeared a little whiter; on October 18, 20 and 24 it was certainly larger than the Jaw, indeed than the Bright Star of Aries, yet a little smaller than the one in the more southern Tail of Cetus. Moreover, just as it had a whiter colour, so too it was endowed with a much livelier and more vibrant light. And these are the things that have so far been observed by us. What will happen next, however — whether it will acquire a still greater size, or will instead soon begin to decrease again — time will tell.

[Margin: Nova in collo Ceti in altiſſimo æthere verſatur.] *The new [star] in the neck of Cetus is situated in the highest aether.*

Since all these things have truly been so, who, I ask, will now judge, or can judge, otherwise than that in the highest aether itself, among the fixed stars themselves, new adventitious bodies have arisen outright; that they have sometimes grown, again decreased, and varied in colour and light, being now brighter, now darker and duller; indeed, that in their own time they have entirely vanished?

[Margin: Cur Autor paullò prolixius novam Stellam in Collo [[C/c]]eti deſcribere voluerit.] *Why the author wished to describe the new star in the Neck of Cetus at somewhat greater length.*

I wished to give the short history of this wonderful star somewhat more fully in this place, with this above all in view: that very many singular and hitherto unheard-of things have been noticed in this new star, and unusual things are still detected in it every year — such as have certainly been observed in no other star since the founding of the world. For whatever [stars] of all the others have shone forth up to now vanished again after a certain space of time had elapsed, and never returned to view in turn.

[Margin: Miras ſubit vicisſitudines.] *It undergoes wonderful vicissitudes.*

But this star in the Neck of Cetus vanishes every year and appears again after some months — and indeed at first as the least little star of all, of dim light and of a reddish and gloomy colour; then it grows gradually, both in bulk and in light, and varies its colour: as may be learned more fully from our *Mercurius*, especially from the history of this wonderful star published in the year 1662.

[Margin: In eodem ſemper Cœli loco affulget.] *It always shines in the same place in the sky.*

Everyone now rightly marvels at the phenomena of this star, and all the more because the genuine causes of its marvellous appearances have so far been so little explored. Above all, what makes the matter more intricate is that this star, whenever it shines forth at all, always stays fixed in the same place in the sky, and does not change its distance from the other fixed stars by even a few seconds, not to say minutes.

[Margin: Autoris de iſto novo Sidere ſententia.] *The author's opinion on this new star.*

Nevertheless, however extremely abstruse the matter may be, let us still disclose our view on it. First, however, you should know, kind reader, that the said star is situated in the highest aether among the very bodies of the fixed stars, since no parallax at all can be detected in it.

But whether that most vast body (which, according to our hypothesis, is 287,496,000 [times] larger than the Earth, as is clear from our *Mercurius*, p. 94; while it sometimes equals the Bright Star of Aries in magnitude) could, after a few months — indeed weeks — have elapsed, be entirely dissipated again, or be reduced to nothing, and that from some natural cause, and shortly afterwards be generated and coagulated anew and grow into so immense a bulk, I think hardly any of the philosophers will readily concede.

[Margin: An Stella illa ſpatio aliquot menſium posſit in nihilum planè redigi, ac rursùs coagulari.] *Whether that star can be reduced entirely to nothing in the space of some months, and coagulated again.*

Nor would I readily grant that that star is moved away from us upward in a straight line, or can be carried up so far that it appears so slight, indeed is entirely extinguished, and then, in its own time, seeks lower regions again along the same straight line, so that it is seen in turn with a large face. This is precisely because such a rectilinear motion is utterly foreign to all reason, and nothing similar is detected in any other body.

[Margin: An motui aliquo rectilineo obnoxia ſit.] *Whether it is subject to some rectilinear motion.*

Then, how very vast an interval, I ask, counted from the fixed stars themselves, would be required to accomplish this straight motion upward before this new star seemed to pass from the magnitude of the second [order] to that of the sixth or seventh order? This would be easy to demonstrate by calculation, if we wished to dwell on these matters longer. Not to mention in what space of time, and by what most rapid and extremely violent motion, this phenomenon would have to be reproduced. Finally, it also seems altogether most absurd that this immense bulk should, in a wonderful way, by God's infinite power and absolute will, be utterly destroyed every year — and indeed sometimes twice, as happened in the years 1661 and 1663 — and shortly afterwards be created again and produced immediately; and that in such a way that those newly and successively created bodies always emerge so strictly in the same place in the sky that they do not deviate toward this or that quarter even by a few seconds, let alone by minutes.

[Margin: Sidus hocce in ColloCeti neutiquam à DEO recens eſſe creatum.] *This star in the Neck of Cetus was by no means newly created by God.*

Since this is so, what explanations then remain, you will ask, by which all those said phenomena met with in that new star in the neck of Cetus can suitably be saved? None indeed, of all that have presented themselves so far (yet let others be free to judge), except one single explanation, soon to be disclosed, by means of which all the phenomena are rightly and successfully saved and explained.

[Margin: Quænam de hâc mirâStellâ rationi convenientior ſit ſententia.] *Which opinion about this wonderful star is more in accord with reason.*

First, however, you should know that this recent star of Cetus dwells in the highest aether among the fixed stars themselves, as we have already sufficiently demonstrated in the short history of this wonderful star, p. 158. If, just as to the Sun, the Moon and the other planets, we attribute to this body an atmosphere of its own, or vaporous orb, the matter is on safe ground and, as it were, already settled without much circumlocution.

[Margin: Datâ, circa illam Stellam atmoſphærâ omnia phænomena optimè ſalvantur.] *Given an atmosphere around that star, all the phenomena are saved very well.*

For then it is by no means necessary that this body, as often as it shines on us, should each time be generated anew from an innate property and some essential power, and again after some months be corrupted or dissipated. Second, there is no need either for it to be subject to some straight motion by which it would be carried away and in turn let down again, most swiftly, beyond what can be said, in a short space of time. Third, nor shall we be forced to take refuge in the omnipotence of the Divine Power. For the atmosphere that surrounds that star properly discloses and demonstrates each of the phenomena — provided, that is, that it is granted; indeed, under pressing necessity, one must by all means

grant a vaporous orb there too, since by no other hypothesis, in our judgement at least, are all the phenomena saved more readily and more correctly.

According to our opinion and hypothesis, therefore, as was shown above, all the bodies of the world belch out and eject evaporations and effluvia, though at some times in greater abundance, now thicker, now thinner, which in their own time are in turn dissipated and vanish.

[Margin: Vniverſa corpora Mundana exſpirationes emittunt.] *All the bodies of the world emit expirations.*

And so around this new star too there is an atmosphere, made up of the exhalations and evaporations issuing from that very body. These expirations, however, flow out more copiously at different times, according to the constitution of their body and the cooperation and influence of the [bodies] round about — just as happens in the Sun and in our Earth. For here among us clouds and vapours are more frequent in autumn than in summer, and the sky is generally more cloudy in winter than in spring; so it is also with the Sun, which brings forth more spots, faculae and shadows in one year than in another.

From this hypothesis, therefore, it follows altogether that when generally all those thicker expirations that cling for some time in the same atmosphere have been dissipated, and the atmosphere has been purged of those denser clouds and dregs, and the aether has been rendered more purified, then, I say, this new star shows its genuine face, as regards magnitude, light and colour.

[Margin: Qua ratione nova illa Stella toties occidat atq́; rursùs oriatur.] *In what way that new star so often sets and rises again.*

But when vapours and evaporations again rise gradually from the body in the open hemisphere of the star facing us, they in turn impede the view of that star to some extent, so that it is seen with more difficulty than before; and hence it appears to all of us successively paler, gloomier and somewhat darker, and all the more so the more frequent the exhalations that emanate from that body and the denser they become. So this star must necessarily decrease gradually as far as appearance goes, and finally, when those clouds, mists and aethereal effluvia have been packed together on every side, vanish altogether, as if it had never existed in the sky — until in turn that matter of the vapours is gradually thinned and made finer, namely when all those exhalations have been dissipated; then it seems to come to life again, to arise, to grow, and to put on its former genuine face. Our terrestrial exhalations too quite often induce such phenomena in the stars, so that now this star, now that, appears now smaller, now gloomier and darker, or redder.

[Margin: Quomodo creſcat ac decreſcat.] *How it grows and decreases.*

Therefore, since these aethereal vapours and evaporations, like terrestrial ones, do not continually burst forth and rise from that celestial body uniformly, of altogether the same density and quality and at the same time, and do not always come together and pack together in the same manner, it can certainly happen that the said star does not always appear to us of the same magnitude, nor of the same colour, nor of the same light (as observation has so far clearly

shown; but is noticed in one year somewhat larger and brighter, in another, again, somewhat smaller, redder and darker, even when it otherwise shines at its greatest. For that reason it is seen by all the inhabitants of the Earth now of the second, now only of the third magnitude.

[Margin: Quo pacto diverſam induat magnitudinem & colorem.] *How it puts on a different magnitude and colour.*

Moreover, the more tenacious and durable these expirations are, the later the said new star meets the eye, and the longer it stays hidden; so that it keeps no fixed or periodic time at all for its first appearance, but begins to blaze up first now in this month, now in that, according to the constitution and quality of the matter.

[Margin: In eodem ſemper Cœli loco; ſed non ſtato tempore redit.] *It always returns in the same place in the sky, but not at a fixed time.*

By this reasoning we now also easily understand how the often-mentioned star always stations itself in the same place in the sky and by no means deviates to the sides: since the star never really perishes entirely and is born anew, but only apparently sets, by reason of overshadowing, veiling or obscuring.

In a quite similar way it is not absurd that some of the remaining fixed stars too can be clouded over and obscured, so that they sometimes shine smaller and darker than usual; indeed, that they can be entirely covered, so that they do not appear anywhere at all, according to the condition of a denser atmosphere — as is recorded to have happened once in Venus and in stars in Orion. Perhaps, believe me, there were even more of these to which the same metamorphosis happened.

[Margin: Fixas poſſe nonnunquam quà magnitudinem variari, ac penitùs etiam evaneſcere.] *That the fixed stars can sometimes vary as regards magnitude, and even vanish entirely.*

But who ever directed his eyes so carefully to those phenomena in the past? Did not almost the whole world, persuaded, that is, by the Peripatetics, hold this very thing among the most absurd [notions]? The ancients would surely sooner have sought water in the sea than have expected such wonderful alterations and changes in the aether itself.

[Margin: Corpora ætherea vicisſitudinibus eſſe obnoxia, Veteres inter abſurda retulerunt.] *That aethereal bodies are subject to vicissitudes, the ancients counted among absurdities.*

But I am thoroughly convinced that it has happened many times, in the past as now, that some fixed stars, as far as appearance goes, have grown somewhat for the reasons given above, and others in turn have decreased. For at this very time some are found much smaller, and some also larger, than Hipparchus and others of the ancients determined them, as will be said more fully a little later — also in our *Machina coelestis*.

[Margin: NonnullæFixæ haud parùm hucuſq; mutatæ ſunt.] *Some fixed stars have changed not a little up to now.*

Yet it is utterly wrong to impute this difference of magnitudes to the carelessness and inattention of the observers; rather, I hold that it must be ascribed solely to their vaporous orb, which surrounds those bodies. And so, given this hypothesis, there is no need at once either to take refuge in divine omnipotence or in occult qualities, or to invent new generations and corruptions of such very vast bodies, and to grant a true accretion and decrease, a real augmentation and diminution. For even some of those [stars] which have grown and decreased, changed their colours and entirely perished (although I would not deny either that other fixed stars too, in our view, can really be generated by their own nature, in their own way, and dissipated again in their own time, like the bodies of comets) may have been created at the very beginning of the world, even though they first came into view after many centuries had elapsed, and a little afterwards perished in turn. Nor is it an objection that hardly any of the new stars has ever risen again once it has set.

[Margin: Nonnullæ tantummodò apparenter pereunt.] *Some perish only apparently.*

The reason is this: that there, in their atmospheres, such immense mists and extremely dark cloudings can sometimes arise, and become so condensed and packed together, that they are dispersed scarcely, if at all, after some centuries; and others are never broken up at all, because of the more tenacious matter of the vapours and the more solid structure of the evaporations. Hence those stars are wrapped in perpetual darkness, so that at no time any longer, even though they are really present, can they be seen and observed by us.

[Margin: De Stellâ novâ in pectoreCygni quamdiu inCœlo ſubſtiterit.] *On the new star in the breast of Cygnus: how long it remained in the sky.*

Into their number that new [star] in the breast of Cygnus must rightly be counted, which from the year 1601 up to the year 1659 and 1660, for a span of almost sixty years, shone clearly like a star of the third magnitude; but from that time it began to decrease, and a little later it perished entirely, so that for three or four years now it has entirely ceased to be among the other fixed stars: just as is now evident to all who look into the sky. Whether it will appear again, or will remain so entirely obscured and covered for ever, surely deserves to be observed accurately by us and by posterity, so that at last, some day, the causes of these appearances may be explored more correctly and more clearly, and uncovered.

Therefore, finally, we again and again rightly conclude that wonderful changes and alterations, and also generations and corruptions, occur not only around the Sun, the Moon and the other planets, as around the Earth, but also around the fixed stars themselves; and moreover that each body has its own atmosphere, into which, from its own essential property, it ceaselessly emits and breathes out the most diverse vapours and exhalations, now thicker and denser, now finer and thinner, to purge and cleanse its body — though far more of them at one time than at another, according to the different influences of the other aethereal bodies.

[Margin: Corpora univerſa Mundana habent ſuas atmoſphæras,in quibus variæ mutationes, alterationes atq; generationes accidunt.] *All the bodies of the world have their own atmospheres, in which various changes, alterations and generations occur.*

In this way, indeed, and with this difference: that the thicker vapours do not depart very far from the body, but always remain in the atmosphere — which rotates perpetually about an axis together with its body and turns in perpetual motion like a vortex — and scarcely ever go beyond it, like the solar spots and our clouds; so that they persist there for some time, according to the nature and constitution of the matter, and are condensed; then, in their own time, they are resolved and dissipated again, so that they can return once more to their body, from which they arose.

[Margin: Craſſiores halitus in atmoſphærâ perſiſtunt, atq; cum eâ ſimul circũgyrantur.] *The thicker vapours persist in the atmosphere and revolve together with it.*

For with every aethereal body it has been so arranged by nature that it has a faculty both expulsive and attractive, and a singular force and inclination to preserve itself.

[Margin: Omne corpus æthereum ſingularem potentiam habet ſe conſervandi.] *Every aethereal body has a singular power of preserving itself.*

Whatever exhalations and expirations, therefore, are expelled from any body, whether by an internal or by an external motion, that very body in its own time draws those very effluvia back again and takes them in, so as to preserve itself, as we have said, and to subsist in its state at all times. Just as usually happens with the exhalations and vapours that our land and sea breathe out. For at times they flow out abundantly into the surrounding air; but then, when occasion offers — namely through rain, mist, dew, blight, snow, hail, hoar-frost, etc. — they return to the earth again, whether they are pressed down by the force of the Sun, or drawn by the earth through some implanted natural faculty. But this has been said of the denser and thicker expirations.

With the finer and thinner effluvia of aethereal bodies, however, the account is indeed almost the same, except that not rarely they depart and withdraw much farther from their body (just as the finer and drier vapours of the earth ascend to a higher place): not only as far as the outer limit of the atmosphere of the body from which they are expelled, but even beyond it; so that they can spread themselves through the whole aether, according to its motion, implanted in them from the beginning (of which we shall say more in Chapter VIII).

[Margin: Subtiliores æthereorum corporum exſpirationes etiam ultra atmoſphæram aſcendunt.] *The finer expirations of aethereal bodies ascend even beyond the atmosphere.*

Indeed, when the course they have taken so permits, it can happen that these mobile vapours, because of the great affinity of all aethereal bodies that exists among them all, not only enter the vortex, or vaporous sphere, now of this, now of some other body or planet, and also of the Earth itself, but sometimes even

pass entirely through it: namely when they have taken on a certain definite impetus, and a certain path toward this or that region of the sky. So while those aethereal vapours and exhalations wander in this way through the whole aethereal air, it not rarely happens that at one time they are thinned out, and at another that these richer and more tenacious vapours thicken and coagulate more and more; so much so that sometimes, out of many rarer exhalations, little clouds and celestial clouds scattered here and there, now one or another, now several more solid and denser aethereal clouds, or corpuscles and nuclei of different sizes, can be generated by this condensation and coagulation.

[Margin: Quâ ratione ex evaporationibus & effluviis æthereis tenuioribus, corpus quoddam denſum,ſive Cometa generari poſſit.] *How a dense body, or comet, can be generated from finer aethereal evaporations and effluvia.*

When these are then joined together and packed close, as other little clouds, or bodies and nuclei, come upon them from the surrounding atmospheres, and also with rarer matter running in between, they finally grow, according to the matter available, into an astonishing mass in that part of the aether. Now when an immense heap of this kind, of nuclei piled one upon another with rarer matter scattered among them here and there, gradually reaches such maturity and solidity that it is able to receive the rays of the sun and reflect them in every direction, and is brought so near to the earth that it falls under our sight, then, I say, it is called a comet; and this is the very thing that constitutes a hairy star.

This cometary body, then, is compounded of the most diverse matter, of the effluvia of diverse aethereal bodies, rarer as well as denser, and of innumerable more solid corpuscles and nuclei, and it grows for a certain time until it attains perfect maturity, according to the constitution and nature of that matter. In the same way, in turn, once it has passed what is, so to speak, its manly age, it begins to grow old: that is, this matter and these nuclei begin, one after another, to be dissolved, separated and thinned, until they are entirely dissipated and reduced to the thinnest and subtlest aethereal vapours, so that at last, at some time, they may return to those globes and to the origin from which they were breathed out and from which they drew their beginnings. This is just what usually happens with the solar spots, with our clouds, and with terrestrial exhalations.

[Margin: Cometarum corpora ex diverſis Cœleſtium corporum effluviis conſtant, atq; certo tempore creſcunt, rursùs decreſcunt.] *The bodies of comets consist of the effluvia of various celestial bodies, and grow for a certain time, [and] decrease again.*

[Margin: Quâ ratione Cometa diſſolvatur.] *How a comet is dissolved.*

Of these, the latter are reduced by the force of the winds and the heat of the Sun into the thinnest air, and sometimes into rain, snow, dew, etc., as we touched on above, and so are carried back again to the earth from which they arose; the former, on the other hand, are in their turn dissipated and dissolved above all by that more vehement circling motion of the Sun. In sum, to embrace our view in a few words: I say that all celestial bodies have some power that

promotes alteration, generation and corruption; next, that the vaporous matter belched out of the bodies is most strongly inclined, by a nature implanted in them, toward coagulation and condensation (these aethereal vapours grow together of their own accord when they are left to themselves, just as clouds do of themselves); and then also that the coagulated matter and the gathered nuclei separate only with difficulty, unless they are both dissipated and resolved by some force, whether external or internal, which so far has not yet become known to us, so that at last that matter may be able to return to where it was ejected.

[Margin: Sententiæ Autoris ſumma, de generatione & corruptione Cometarum.] *Summary of the author's view on the generation and corruption of comets.*

[Margin: Materia illa Cœleſtis, ut Terreſtris ex inſitâ facultate naturali propenſionem habet ad condenſationem.] *That celestial matter, like terrestrial [matter], has from an implanted natural faculty an inclination toward condensation.*

Hence it comes about, since all the wandering and fixed stars, being extremely vast bodies, unceasingly breathe out and eject exhalations and vapours, that successively much finer and thinner matter is dissipated here and there through the whole aethereal air; this matter afterwards, by the power of gathering itself together that nature has implanted in these effluvia (as we find in our terrestrial vapours), gradually fly together and are condensed. For the whole of nature seeks condensation; and that rarer matter of the celestial bodies, too, has a physical inclination and a natural propensity to take condensation upon itself, as toward its own perfection — certainly no differently from all sublunary things. Indeed, the denser the celestial matter (that is, the evaporations) is, the more perfect it is. From this it follows — since matter always gapes more and more after a new form — that the aethereal vapours and exhalations gradually gather together more and more, and, coming together, are condensed by that implanted, hidden natural faculty.

Moreover, in whatever globe's atmosphere such matter, placed there, and a rich vapour are first coagulated, it is in the vaporous orb of that planet, and in that place, that the comet takes its beginning, or is, so to speak, first born.

[Margin: Prima Cometæ nativitas.] *The first birth of a comet.*

For example, let it be that its true birth took place around Saturn, and that the matter began to coagulate there. When this matter has become a little denser and has been made more suitable (for the denser a body is, the fitter it is for motion), it begins to move (for what reasons, and in what manner, will be told more fully in Book IX), and indeed toward the extremity of that system or vortex; at last it even leaves this entirely and enters the vastest aether. Indeed, from time to time, according to the course of the path of the newly coagulated matter, or comet, it enters the nearest system of a neighbouring planet, especially if other exhalations happen to be present there with which this matter, which arose earlier, can be united and joined — while it nevertheless goes on toward where, from its first beginning, the more powerful matter,

that is, began its impetus, and toward which it tends (for the lesser yields to the greater); and indeed with a nearly straight motion, as will be properly demonstrated in Book IX.

[Margin: Quomodo moveatur.] *How it is moved.*

So while that cometary matter thus pursues the path it has begun and set before itself, all those vapours and exhalations that it meets here and there in that tract associate and join themselves, of their own accord and easily, to that greater body in motion. As a result it not only grows continuously, but also acquires a greater impetus for moving itself (for motion produces motive force) toward the region which the greater part of the exhalations set out at the beginning to make for.

[Margin: Quâ ratione tractu temporis in curſu incrementa Cometa capiat.] *How a comet takes on growth in the course of time during its journey.*

Since, then, more and more of the finer matter, which is dispersed everywhere through the aether from various atmospheres, clings to that moving body from every side, it finally grows into a certain vast body. And just as this body is composed of the most diverse matter of diverse planets, so it is also composed of various corpuscles and nuclei, partly denser, partly rarer, and likewise of different kind and shape — now round, as being most closely akin to union, now of another [shape].

But to state still more clearly how the effluvia of all the planets, too, can sometimes coalesce into one cometary body: know that when, for example, matter newly coagulated and condensed in the vortex of Saturn acquires a motion toward the Sun, it must then necessarily enter first the orb of Jupiter, then those of Mars, the Earth, Venus and Mercury, and so at last also that of the Sun itself. On this journey, since certain effluvia are sometimes given off from any system of the planets, it happens, as we touched on above, that by a certain magnetic nature of joining themselves together they easily coalesce and cling also to other matter that comes upon them, and also that this more dilute matter that it meets accompanies of its own accord that [matter], already in motion, denser and larger.

[Margin: Quo pacto omnium Planetarum effluvia in unum corpus Cometicum coeant.] *How the effluvia of all the planets come together into one cometary body.*

Because in homogeneous bodies there is always a certain quality by which their parts are borne toward one another, attract one another mutually, and tend toward the same place, as Aristarchus of Samos rightly and skilfully says in his *System of the World*.

[Margin: Corporibus homogeneis, ineſt qualitas quâ partes illorum ad ſe invicem feruntur, atq; in eundem tendunt locum.] *In homogeneous bodies there is a quality by which their parts are borne toward one another and tend toward the same place.*

Above all, this newly formed comet acquires no small strength and force when it passes through the sphere of the Sun. Since far more frequent evaporations are found there than elsewhere (namely the finer matter of the spots, frequently belched out of so vast a body), the comet therefore at that time also grows, most of all and perceptibly, into a great heap and mass, and at that time too it becomes much more compact.

[Margin: Verſans Cometa circa Solem, maxima plerumq́; incrementa haurit.] *A comet moving about the Sun usually takes in its greatest increase.*

For, as far as can be gathered from the nature of the solar spots, the solar exhalations and smoky evaporations are strongly inclined toward condensation, more than the effluvia of all the other planets; so that you may, not undeservedly, regard that solar matter in comets not only as the more principal [matter], but also as that natural glue, so to speak, and binding, which more and more unites, glues together and binds all the rest of the gathered matter.

[Margin: Evaporationes Solares adcondenſationem valdè propendent,atq́; exhalationes reliquorum Planetarum quaſi conglutinant.] *Solar evaporations are strongly inclined toward condensation and, as it were, glue together the exhalations of the other planets.*

Hence almost all comets, namely when they are nearest to the Sun and the Earth, are nearly at their largest and densest of all.

[Margin: Cometæ quando Soli Terræquè ſunt vicinisſimi,plerũq́; ſunt maximi & denſisſimi.] *Comets, when they are nearest to the Sun and the Earth, are usually at their largest and densest.*

At the same time, however, it cannot be denied that comets decrease again a little afterwards, that is, before they have entirely traversed the orb of the Sun. The reason is this: just as all aethereal bodies breathe out exhalations at a certain time, so they also reclaim and attract them in their own time. From this it happens that, as long as the comet moves within the sphere of the Sun, the solar evaporations do indeed cling to it; but before it leaves that sphere, the Sun calls back and attracts those vapours again. Hence [the comet] must necessarily decrease, since at the least the principal and greater part of the solar expirations leaves the comet within that sphere, and suffers itself only reluctantly to be torn away, as it were, from its native soil, or to be led away and drawn out of it. I would have the same said also of the evaporations of the other planets.

[Margin: Quare Cometæ plerunq́; decreſcant, priusquam Orbem Solarem trajiciunt.] *Why comets usually decrease before they pass through the solar orb.*

But indeed, you will say, does not this very point most strongly contradict your opinion: namely, that the vapours of any planet like to linger in their own orb or sphere, in which they were emitted, and leave it only with great difficulty?

[Margin: Cujusq́; Planetæ halit[9] ſphæram, ſeu orbem ſuum ægrè deſerunt.] *The vapours of each planet leave their own sphere, or orb, only reluctantly.*

Not at all, certainly. Even if I grant that the exhalations of Saturn can of their own accord enter the sphere of Jupiter, Mars, the Earth, Venus and all the

rest; likewise the evaporations of Jupiter the spheres of Mars, the Earth, Venus, etc.; and again the expirations of Mars those of the Earth, Venus, Mercury and the Sun, and so on in succession, I do not on that account contradict myself. For it is certain that all the planets, and the Earth itself, recognise the Sun as their centre. Therefore the sphere of Saturn, as that of the body most remote of all from the Sun, embraces all the other spheres within itself; next, the sphere of Jupiter contains those of Mars, the Earth, Venus, Mercury and the Sun; again, the orb of Mars [contains] the orb of the Earth, Venus, Mercury and the Sun; the sphere of the Earth [contains] the sphere of Venus, Mercury and the Sun; the sphere of Venus comprehends those of Mercury and the Sun; and finally the orb of Mercury surrounds only that of the Sun, so that the sphere of the Sun is the innermost and smallest of all.

[Margin: Planetæ quotquot ſunt, Solem pro centro habent.] *All the planets, however many there are, have the Sun as their centre.*

Therefore, although the exhalations of Saturn enter the spheres of the other planets, they nevertheless do not, if you consider the matter carefully, leave their own sphere, since the sphere of Saturn, as the largest, comprehends all the others. The same is to be understood of the evaporations of Jupiter: the smaller spheres, indeed, of the in- ferior planets, such as Mars, the Earth, Venus and the Sun, they can enter; but their own (namely Jupiter's) they can by no means exceed, so as to reach the sphere of Saturn. In the same way, the effluvia of Mars may indeed pass through the orbs of the Earth, Venus, Mercury and the Sun, but not pass beyond that of Jupiter. The same holds for those finer and drier exhalations of the Earth, if they ever pass beyond the atmosphere; but they rarely get that far, because for the most part they are so very impure and heavy that they can scarcely leave the vaporous orb.

[Margin: Quousq́; Planetarum materia, ſive halitus propelli poſſit.] *How far the matter, or vapour, of the planets can be driven.*

The vapours of Venus, on the other hand, can pass through the sphere of Mercury and the Sun, but cannot reach the Earth; and I would have you understand the same, in succession, of the effluvia of the remaining lower [planets]. Therefore, since the sphere of the Sun is the innermost and smallest, in this respect the solar vapours and exhalations are not allowed to range out into any other orb.

With these things supposed, our view stands firm: namely, just as the solar expirations associate themselves with the comet, and join themselves to it, only in its orb, so also, within the same sphere of the Sun, before the comet has passed entirely through it, the principal part of the exhalations remains in that sphere, so that they may return to their vortex and their origin, namely the Sun, from which they came out.

[Margin: In orbe Solis præcipua materia Cometica datur.] *In the orb of the Sun the principal cometary matter is supplied.*

Accordingly, as soon as comets enter the sphere of the Sun, they must certainly grow, by reason of the solar matter that clings there in abundance;

but before they leave that sphere of the Sun again, they also begin to decrease, because the Sun calls back and attracts what is its own, and also lets anything go out of its sphere only reluctantly. Similarly, in the course of time the comet is diminished more and more. For shortly afterwards Mercury too, then Venus and the Earth, if any [exhalations of theirs] are present, and finally Mars and Jupiter: each, that is, calls away and draws to itself its own exhalations, so that in the end nothing but that first matter of Saturn is left on its own (that is, when comets have consisted of the effluvia of all the planets). And this matter is no less consumed and dissolved at last, or rather so thinned that a return to its own body is likewise granted to it.

[Margin: Qu[[ò/o]]modo Cometa attenuetur, & quâ ratione, & ordine ſinguli Planetæ ſuas exſpirationes vicisſim repetant atq; attrahant.] *How a comet is thinned, and in what manner and order the individual planets in turn reclaim and attract their own expirations.*

In this way, then, comets are generated from the diverse effluvia of diverse planets and grow, and in turn decrease and are dissolved, so that in due time a way back may lie open, successively, for these exhalations and smoky evaporations to their own body at last, and to the origin from which they came forth. For, as has repeatedly been urged already, the matter of any planet flows back together, by a certain implanted, natural, magnetic power, to that very body, as to its own principle, from which that matter was drawn out.

For this reason I am entirely convinced, since almost all the comets that come into our view usually take their path through the sphere of the Sun, and so approach the Sun at a certain time, namely when they are nearly closer to our Earth (for comets are almost always seen only in quadrature and in opposition to the Sun), that then too, at nearly every time, the first dissolution of comets takes place near the Sun, as about the true centre of the planetary system, and that, by reason of the matter called away by the Sun, as we touched on above, they begin to decrease there.

[Margin: Omnes propemodùm Cometæ per ſphæram feruntur Solis.] *Almost all comets are carried through the sphere of the Sun.*

[Margin: PrimaCometarum diſſolutio, plerunq́ue fit circa Solem.] *The first dissolution of comets usually takes place about the Sun.*

For, as the history of comets bears witness, no comet has ever shone which, once it had passed the Sun as the centre of the universe (that is, according to the inclination of its trajectory line), did not at once and continuously begin to decrease as to matter and substance, [and to be] rare- fied and attenuated: as is easily detected from the rarity of its body and the weakness of its light.

There is no reason, however, for you to think that each and every comet is always generated or composed from the effluvia of all the planets; only some are. For some are born first in the sphere of Jupiter, and these cannot reach Saturn; others are generated originally in the domicile of Mars, and to these there is passage neither to Saturn nor to Jupiter; others in turn remain in the

sphere of Venus, namely those that took their beginnings there; and so on, so that one [comet] may consist of nothing but the evaporations of the Sun.

[Margin: Non univerſi Cometæ ex omnium Planetarum evaporationibus conſtant.] *Not all comets consist of the evaporations of all the planets.*

Among these, some can be carried across in such a way (especially if they are thrust out of the atmospheres of the superior planets) that they in no way touch the orbs of the inferior planets, but must leave them to one side; and so they are made by no means sharers in those [planets'] effluvia. For they are altogether unable to attract the exhalations of the spheres they do not enter. Therefore one comet consists of the evaporations of only some [planets], two, three or more, namely by reason of the trajectory they take, and of their course, according to the quarter toward which they direct it: all of which we shall treat more fully in its place. And these are the things we proposed to say on this occasion about genuine comets, which are born from the subtler and purer effluvia of the ethereal bodies.

It remains for us still to touch briefly on those pseudo-comets, or spurious ones, which are produced from the more impure and grosser evaporations in the individual atmospheres of the individual bodies. On these my view is this: that sometimes, indeed, a certain body is coagulated and composed from such grosser exhalations, as if from their dregs; but it is never permitted to leave the atmosphere, so that it is generated and corrupted in the vaporous orb, and also lasts only a short space of time.

[Margin: De pſeudo-Cometis: ubinam, & quomodo generentur.] *On pseudo-comets: where, and how, they are generated.*

This body, however, is wrongly called a comet; it is only a chasma [chaſma], or a meteor [meteoron], such as we not rarely see here among us in the surrounding air.

[Margin: Dari chaſmata, & meteora ætherea.] *That there are chasmata and ethereal meteors.*

In the atmosphere of the Sun such[547] special comets (if these momentary bodies may be so called) are observed at almost every time: namely, those solar spots. Just as they are produced in the atmosphere from more impure and denser exhalations, so also they always persist in it until their destruction, and, as the observations of everyone teach, never desert it and leave it; so that these bodies, if we wish to speak properly, are nothing but pseudo-comets, or rather solar meteors.

[Margin: De meteoris Solaribus.] *On solar meteors.*

Moreover, it seems very consistent [with reason] that such bodies or momentary meteors are generated in the atmospheres of all the other planets too, likewise in their own way, and are not rarely present there. But that they do not strike our senses in that way, and so distinctly, as the terrestrial and solar ones do, anyone may readily gather: namely, because of the excessive

[547]the page prints talcs; the sense is tales, "such"

distance, the rarity of the matter (for no one, surely, will deny that the effluvia of the other planets, even those very much grosser, are far thinner than these of ours and the solar ones) and the smallness of the body, they can in no way be discerned. For I think that the whole apparent atmosphere of Saturn and of Jupiter is scarcely 2′ or 3′ in diameter, and [those] of the remaining planets are also scarcely somewhat larger: whether anything can be seen in them there, either with the naked or with the armed eye, judge for yourself, I beg you, wise reader.

[Margin: Quanta ſit Saturni, Joviſq; apparens atmoſphæra.] *How large the apparent atmosphere of Saturn and of Jupiter is.*

But let it suffice to have merely touched on these spurious comets; let us return to the genuine ones, so that we may now also discuss where they acquire that varied and most diverse colour which they display. For it is plain that not all comets, at every time, have shown a similar and identical colour: some, namely, were splendid and bright, like the Sun; others fiery, ruddy and glowing red; others yellow and golden, like amber, which are otherwise called Chrysii [Chryſios]; others silvery and white; others leaden, pale and somewhat livid; others blackish and dusky; others changed colour in succession.

[Margin: De variis Cometarum coloribus, eorumq́; origine.] *On the various colours of comets, and their origin.*

These most diverse colours certainly arise from nowhere else than from this: that [comets] are generated and coalesce from the most diverse matter of diverse bodies; then, that they are not always equally compacted and consolidated; and further, that they consist now of more and smaller nuclei, now of fewer, larger and more solid ones. For just as no one can deny that each planet enjoys a different light and an unlike colour (since Saturn appears somewhat livid and ashen; Jupiter whitish and bright; Mars glowing red and fiery; Venus silvery and shining white; Mercury yellowish; the Sun golden and fiery; the Moon white and mild, at all times without exception, as is manifest to anyone once their hair [capillitio] and their adventitious light are taken away), so likewise the effluvia that are breathed out and cast forth from the individual bodies of the planets must also be of the most diverse colour.

[Margin: Singuli Planetarum peculiarem colorem præ ſe ferunt, quem eorum effluvia etiam æmulantur.] *Each of the planets displays its own particular colour, which their effluvia also imitate.*

By reason, therefore, of the most diverse exhalations and evaporations, and insofar as comets have been coagulated from these or those expirations of this or that planet, or consist of one or another predominant and prevailing matter, to that extent they reproduce this or that colour; and this colour likewise appears the more intense or the more subdued, the rarer, or the denser and more solid, the matter, together with the nuclei, from which it is generated and composed.

Hence [it may be inferred] that comets as splendid and bright as those that appeared in the year 119 before the birth of Christ, which Seneca mentions in chapter 15 of Book VII of the *Natural Questions*, and likewise in the years

after the birth of Christ 1264 and 1521, were born entirely of the Sun, or of solar matter, or at least that in these same hairy stars the solar effluvia were the more powerful. Next, in those that were of a ruddy, glowing red and fiery colour, the matter of Mars and of the Sun prevailed; such as those in the year of Christ 662, 1526, 1554, 1556 and 1618. Those, however, that were seen yellow and golden, like the one in the year 1531 and 1533: these, I say, arose alike from Jupiter and Mercury and alike from the evaporations of the Sun. Again, of those that showed a silvery and whitish colour, such as appeared in the year 1463, the greater part of the matter was breathed out from Venus, perhaps, Jupiter and its companions. But as for those so pale, somewhat livid and dark: certainly, if they did not coalesce from the mere effluvia of Saturn and Jupiter and their companions, those effluvia at least predominated in them; such as were seen in the years 1240, 1558, 1569, 1580, 1585, 1590, 1596, 1607, and also 1652.

[Margin: Ex coloribus Cometar. haud malè divinari poteſt, ex cujus Planetæ exhalationibus corpus Cometicum ſit compoſitum; vel ſaltem cujus materia in eo prædominetur.] *From the colours of comets one can guess, not badly, from which planet's exhalations the cometary body is composed, or at least whose matter predominates in it.*

With this mournful and gloomier face the greatest part of comets usually shines; and I think this comes about because most, or very many, take their birth only from the atmospheres of Saturn and Jupiter and their evaporations, and abound in those same effluvia.

[Margin: Cur pleriq́ue Cometæ pallidi & ſublividi ſint ?] *Why most comets are pale and somewhat livid.*

For these planets, being most vast and immense bodies, are able, together with the companions attached to them, always to breathe out much matter and to supply it to comets. Not to mention that the vapours of these planets rarely come together into a very dense mass; and are only with difficulty condensed so far that large and solid nuclei are produced; so that lividness and pallor must necessarily arise from this, and such comets must take on a leaden, or ashen, colour.

I add that from this foundation, and from these colours of comets, distinguished by their variety, one can also in some measure judge, not badly, both about the native soil of any comet (from where, and from which planets' atmospheres, they were born and cast out) and also conjecture whether they will depart from the Earth and the Sun a little or a great deal, and how far (though only in a rougher way), and which will be higher and more remote.

[Margin: Ex coloribus quadantenus conjicitur, quo inCœli loco quivis Cometarum prognatus,& quousq́; à terrâ propemodùm diſceſſurus ſit.] *From the colours one conjectures to some extent in what place of the heavens any of the comets was born, and roughly how far it will depart from the Earth.*

I hold, moreover, that pale and somewhat livid comets can advance higher and farther than the ruddier and more splendid ones. The reason is this: the matter of the latter, just as it flows out from Mars, Mercury and the Sun, is so

dispersed again in their spheres and orbs and flows away; whereas [the matter] of the former, according as they took their origin from the spheres of the superior bodies, [is dispersed there] if they in turn travel to where they came from.

Accordingly, as far as I can scent it, it will also be open to us to divine to some extent about their parallaxes: namely, that the paler and ashen comets always have smaller parallaxes, and the ruddier ones larger; since [the paler ones] travel higher, or farther, namely to their own spheres. And although you may think that I am here weaving a rope out of sand, yet when the observations of comets are considered and accurately weighed, these things are not so far removed from reason.

[Margin: Cometæ pallidiores pleruńq; altiores, rubicundioribus exiſtunt.] *Paler comets are usually higher than ruddier ones.*

For the comet of the year 1577, which was conspicuous for a somewhat livid whiteness, had receded toward its end to 1733 semidiameters of the Earth, as Tycho testifies in the proem on that same comet. The comet of the year 1580, which was likewise somewhat pale, reached as far as Saturn. The comet of the year 1585, which was endowed with a dim, rare and nebulous light, had no parallax at all toward its departure, as one may read in Tycho's *Epist.* to the Landgrave; so that it is certain it reached as far as Saturn. In the comet of the year 1590, which likewise shone with a pale and somewhat dark face, Tycho detected not even a trace of parallax (*Epist.* to the Landgrave, p. 174). Finally, since the comet of the year 1618 was far ruddier than our [comet] of the year 1652, it was for that reason also found to be far lower. For the former reached only as far as the Sun, whereas the latter, the pale one, was much higher than the Sun: indeed its parallax toward its departure could barely, if at all, be perceived.

[Margin: Exemplis probatur opinionem hanc non adeò eſſe inconvenientem.] *It is shown by examples that this opinion is not so unfitting.*

But whether this phenomenon holds in all comets, or only in some, observations will teach. I urge and counsel posterity, and above all the sons of the astrologers, to attend to them seriously, so that at last they may some day lay more solid foundations for their judicial astrology, and may in future have clearer grounds for divining the outcomes of times and affairs from the distinct and most diverse colours of comets.

[Margin: Conſilium pro Aſtrologis: quâ ratione ex coloribus aliquid ſolidius conjecturare poſſint.] *Advice for astrologers: by what means they may conjecture something more solid from the colours.*

Now something must also be said about those comets that rather often take on one colour after another in their trajectory, and above all, what the genuine reason for this phenomenon is. You will easily perceive this, however, if you weigh well everything we mentioned a little earlier: namely, that this can happen in those comets that arose from unlike expirations of diverse bodies.

For one that was born only from the evaporations of a single planet always shows, as far as I understand, a similar colour; except that brighter

[Margin: Vnde nonnulli Cometæ in trajectione colorem mutent, & quinam ſint conſtantioris coloris.] *From what cause some comets change colour in their trajectory, and which are of a more constant colour.*

and more splendid it may sometimes appear, according to the different degrees of density and rarity; but the rest, which enjoy differing matter, are very much subject to change. For as often as new matter comes in abundantly from one body after another, so often do the colours change. Above all, the exhalations of Mars and of the Sun seem to contribute much to this business: for as soon as these accrue to some new body of comets, they vary it greatly in respect of colour.

Accordingly, comets in the sphere of the Sun and near it are mostly seen glowing red, according to the matter supplied; and again, as soon as they recede from the Sun once more, they become[548] paler: because Mercury soon, and then Mars, take back their own, and at last only the evaporations of Jupiter and Saturn are left, which, according to the nature of their body, appear nothing but somewhat livid and growing pale.

[Margin: Quare in regione Solis Cometæ ſæpiùs rutili videantur.] *Why comets in the region of the Sun are rather often seen glowing red.*

Therefore, to the extent that comets successively take on increases and decreases, and become partakers of the matter of this or that body, to that extent, I say, the colours change, and for it, according, that is, to the different degrees of density and rarity, they become more vivid. So that all this may shine out the more clearly, we shall set it out in a diagram below.

Now, before we pass on to other matters, let us sketch comets, and new stars as well, according to our own view, though only with a rougher brush, so that you may have some general knowledge of all the things that remain to be set forth by us in their place and accurately unravelled. A comet, therefore, is an ethereal, hairy or bearded, temporary body; as to its head, not altogether globular but disc-shaped; formed from the vapours and smoky evaporations both of the Sun and of all the remaining planets; and indeed composed of manifold corpuscles and nuclei, partly round, partly various irregular ones, with rarer matter sprinkled here and there. Its entire matter, like the bodies from which they came forth, enjoys no native light at all, but draws all that it has entirely from the Sun.

[Margin: Quid reverà, ſit Cometa, ex menteAutoris.] *What a comet really is, in the author's view.*

Its tail, moreover, is produced from solar rays reflected and refracted, while they are arrested in a certain rarer medium, as in a cometary atmosphere surrounding the comet, on the side turned away from the Sun. For the rest, the body itself is movable: not indeed with a double motion, in some eccentric

[548] the page prints redduntut; the sense is redduntur, "they become"

and about an axis, as the other ethereal and eternal bodies are, but only with an almost rectilinear motion, always turning its face almost directly toward the Sun, according to that impetus which that earlier atmosphere impressed upon, and communicated to, the first coagulated matter once it was ejected.

With new stars, however, the case is somewhat different. For although they agree in many respects, in many they also differ not a little: as much in respect of the place where they first coalesce as in respect of the matter from which they are generated, and also in respect of the shape they display; to say nothing of other things.

[Margin: Quid ſint novæ Stellæ, & quomodo procreentur.] *What new stars are, and how they are produced.*

To begin with, new stars, no differently from comets, are ethereal temporary bodies; which, however, draw their origin by no means from the effluvia and evaporations of the wandering bodies, but from those of the fixed [stars] themselves. And just as the bodies of the fixed [stars], according to the common opinion, are entirely immobile and endowed with native light, so those new ones, which are produced from them, come together, coalesce and grow from luminous matter in some fixed place, upon one centre, into some one body and an almost round nucleus; and, immobile in that same place, (com- mon motion of all the fixed [stars], if you except that) they subsist continuously, just like the bodies from which they arose. Moreover, they appear far brighter and more splendid (since they consist of one single, large, very dense nucleus) than the offspring of the planets, which is produced from various very small and mostly rarer nuclei and from thinner matter.

[Margin: Quare novæ Stellæ Cometas claritate ſuperent.] *Why new stars surpass comets in brightness.*

Above all, they surpass comets greatly in brightness, because they are illuminated not by the Sun but by the innumerable fixed [stars] themselves, and then because they revolve unceasingly about an axis, as is natural to all the coeval fixed [stars]; and from this the twinkling and that vehement vibration of light arise in part. For the rest, these new stars lack any tail entirely, and scatter no hair at all round about them; nor indeed can this ever happen, because they do not consist of many differing nuclei and bodies, as comets do, but of one single nucleus only, namely an almost round body, which in no way grants passage to the rays either of the Sun or of other stars, so that a tail could be displayed from the refraction and reflection of the rays — however much new stars too may have their own atmospheres.

[Margin: Cur nullam exhibeant Comam.] *Why they display no hair.*

Add to this that the Sun's rays cannot reach that far; indeed, even if it be granted that they can get there, they nevertheless do not exert such great force there as to imbue with light a body that is dark in itself. For the whole diameter of the Sun, seen from some fixed [star], appears, because of the immense distance, scarcely 6‴ in size; so that from it a perceptible tail could by no means

be produced, even if the matter were not so compact on every side but rarer and sprinkled through it.

[Margin: Quanta ſit diameter Solis ex Fixis ſpectata.] *How large the diameter of the Sun is, seen from the fixed [stars].*

Indeed, even though the Sun should cast its rays all the way to the fixed [stars] unimpaired and equally vivid and strong, and some new body fit to receive them should also be supposed, nevertheless a tail arising from them would certainly by no means come into our sight.

For since there is almost no sensible ratio between the sphere of the fixed stars and the great orb [orbis magnus], so that almost all parallax in the fixed [stars] vanishes entirely (if you except a very few seconds), the whole great orb is therefore like a centre of that immense sphere of the fixed [stars], which stands to the former as 1 to 41,250; and so it will make no difference whether the bodies of the fixed [stars] are considered from the Sun or from the Earth.

[Margin: Ratio orbis magni ad Sphæram Stellarum Fixarum.] *The ratio of the great orb to the sphere of the fixed stars.*

Therefore all tails, even if they were granted to new stars by the Sun, entirely elude the keenness of the eyes, as though covered by the bodies. For tails are always cast toward the part opposite the Sun. But whatever is opposite to the Sun is also opposite to us, because, as you have learned, the whole great orb is of no moment at all with respect to the sphere of the fixed [stars]. Therefore whatever lies hidden on the rear side of the stars by no means meets the eyes; and so the tails of new stars too, if any are produced by the solar rays, are by no means seen. Rather, at every time, in whatever place of the ecliptic the Earth or the Sun may stand, new stars shine entirely stripped of hair, as has also been observed in all that have ever shone forth.

[Margin: Non tamen omnes novæ Stellæ pari ratione generantur & producuntur; ſed aliæ tantùm apparenter oriuntur,& occidunt.] *Not all new stars, however, are generated and produced in the same way; but some only apparently rise and set.*

Yet I do not think that each and every new star is first born and takes its beginnings from matter supplied and flowing in, still less that it really grows little by little, decreases again in the same way, or finally vanishes through the rarefaction and attenuation of the matter; but that new stars can also sometimes arise in another way and set entirely — that is, according to appearance; [stars] which nevertheless in reality, in the same place of the heaven, perpetually unharmed remain, as we have already lightly touched on above, at p. 378, and shall, God granting, also discuss more fully in its place. Let this, then, suffice on these matters for the present. Let us return to comets, in order to remove those doubts that might perhaps be raised against our hypothesis, and then to answer the questions duly and accurately.

First, then: since we have asserted that the planets, and all ethereal bodies as well, continuously breathe out effluvia and eject exhalations, which, according to an innate natural faculty, are condensed, increased, resolved, diminished and

dissipated, and also, in time, are recalled and attracted by those bodies from which they came forth, it is asked, not without reason, what that is which brings all these things about and perpetually preserves each body in its own state.

[Margin: Quænam ſit cauſa agens, in expellendis effluviis & exſpirationibus ex corporibus æthereis, & generandis Cometis.] *What the agent cause is in expelling effluvia and expirations from the ethereal bodies, and in generating comets.*

As for the first cause, if it need only be pointed out, the matter will be dispatched by us very briefly: namely, that the supreme Founder and Preserver of the universe created those ethereal bodies in such a way, and preserves and rules them in such an order, that it can by no means happen otherwise than that they constantly emit breaths and vapours and take them back again. But truly, this would be to have recourse to the first cause acting freely, which is entirely unbecoming to one discoursing on natural and physical matters. Therefore let us leave that first cause aside for the present and pass on to the second cause.

If this is to be inquired into accurately and duly, it will, beyond all doubt, seem to you, my reader, an arduous business, and the discussion likely to be lengthy. But however laborious the matter really is, let us nevertheless deal with it briefly, and so sketch the thing itself, explain it, and compare it with other things known in themselves, that what is sought may easily be grasped by most people — although we deliberately do not designate it by one single name, as was indeed done partly by the ancient and partly by the younger philosophers.

[Margin: Non adeò ardua res eſt, cauſam hujus rei indagare operantem, ſive expellentem.] *It is not so arduous a matter to track down the operating, or expelling, cause of this thing.*

Of these, some from among the ancients, such as the Platonists, and from among the more recent Jordanus Bruno [Giordano Bruno], Egydius Personerius de Robberval [Gilles Personne de Roberval] etc., said that it is the soul of the world and of the ethereal bodies, governing all things in this way; others would have it that it is a spirit; others, an intrinsic form; others, an occult quality; others, a magnetic virtue; others, an essential property; others, a vegetative faculty — to say nothing of the remaining opinions.

[Margin: Variæ Philoſophorum hâc de re opiniones.] *Various opinions of the philosophers on this matter.*

But to us it makes no difference whether you name it thus or otherwise hereafter; let everyone be free to do so. Nor let us go down into the arena with anyone on that matter, nor on this occasion seize upon any particular one of all those opinions as the truer. We lay down only this: that it is that very natural faculty, implanted in the celestial bodies and in the whole ethereal air, which expels, ejects, condenses, rarefies, dissipates, dissolves and attracts all things, and accomplishes everything, which brings about all those things in and around our Earth and performs that very function — the faculty, namely, which begets metals and produces trees, plants and fruits of every kind from the earth, and

thrusts out and ejects the most diverse vapours and exhalations, from which various meteors are generated and then preserved for some while in the air; and at last, in the course of time, those breaths are brought back, or attracted, to the earth in certain ways.

[Margin: Cauſam iſtam eſſe planè eandem, quæ in, & circa Terram talia operatur; quo nomine autem diſtinguenda ſit, perinde eſt, dummodo rem ipſam intelligas[[./,]]] *That this cause is entirely the same as the one that brings about such things in and around the Earth; but by what name it should be distinguished makes no difference, provided you understand the thing itself.*

That very faculty, I say, is the one which brings forth all our sublunary meteors, and at the same time exhales, condenses, attenuates and in turn dissipates all the matter of the solar spots, and preserves all things in a perpetual series; this very [faculty] too all co- mets and new stars it begets from the ethereal bodies, preserves for some while in the aether, and afterwards dissolves; and at length, in its own time, it recalls the matter to whatever body it flowed out of, restoring and returning to each its own.

[Margin: Quo fine corpora Mundana effluvia & exhalationes emittant, & ejiciant.] *To what end the bodies of the world emit and eject effluvia and exhalations.*

Just as this intrinsic virtue (if one cares to designate that very thing by this name) always tends, on our earth and in its air, toward this end, and exerts its forces so that it may purge and thoroughly cleanse the Earth and the air — namely by breathing out superfluous exhalations and evaporations, and by condensing, attenuating and again resolving them — so it operates in almost the same way, but nevertheless in its own manner, so that that superfluous matter, now rarer, now somewhat thicker, is breathed out and thrust out from all the celestial bodies (no differently from what is admitted by all in the case of the Sun, around the spots), and at times is condensed and aggregated. From this [matter], finally, it sometimes brings forth and completes new stars and comets, that is, temporary stars and temporary planets; and afterwards it again resolves, attenuates and dissipates those newly arisen bodies, according to the proportion of the matter of which they consist, since they can by no means at all attain such absolute perfection as those bodies obtained from God, Best and Greatest, at the beginning of the world; and hence they too are not so very perennial and durable, but only perishable and temporary.

[Margin: Corpora ætherea temporaria nunquam ad perfectionem coævorum corporum perveniunt.] *Temporary ethereal bodies never attain the perfection of the coeval bodies.*

And nature produces all these things, and in turn destroys them, to this end: that the stars and the aether, like the Earth and the air, may be purged and cleared of dregs. For individual natural things always gape after perfection and a better form, which consists above all in purity.

But if you would rather ascribe this power, which works and accomplishes all things, to that struggle which takes place in the celestial bodies no differently than on the Earth, and which expels and thrusts out now some, now other

abundant parts (since they likewise consist entirely of heterogeneous parts), it will do me no harm.

[Margin: Quilibet globus æthereus,habet varias innatas qualitates.] *Every ethereal globe has various innate qualities.*

For I have no doubt at all that every ethereal globe also has its own heat, its own cold, dryness and moisture, heaviness and lightness — yet according to the character of its own virtue; and accordingly it does not seem absurd that the drawing-out of effluvia from the stars can come about by reason of those qualities implanted in all bodies. But if anyone should not yet be willing to rest content, I will say these few things into his ear, with which, I hope, he will be very well content, and would make no retort [?]. Tell me, pray: of how many causes and effects of sublunary things, much nearer to us, are we entirely ignorant? Why then do you wonder that we cannot understand and uncover so very accurately and fully that genuine cause which accomplishes all those things in those far more remote bodies?

[Margin: Multarum rerum etiam ſublunarium cauſæ, & effectus ignorantur.] *The causes and effects of many things, even sublunary ones, are unknown.*

It is enough, I think, to know just this: that in the ethereal bodies there is that very expulsive and attractive virtue which is natural to our Earth. But if anyone puffed up with learning should persuade himself that he sufficiently understands that intrinsic cause which works all things and inheres in the Earth and in sublunary things, he, indeed, has already rightly seen through the whole business, and will at the same time easily comprehend in what way each and every thing in the ethereal bodies is drawn out, preserved and brought back, so that nothing at all remains to be added.

[Margin: An corpora ætherea tantùm materiæ, ſine detrimento ejicere valeant,quò tot immenſa corpora aſcititia generari queant.] *Whether the ethereal bodies can eject so much matter without detriment, so that so many immense adventitious bodies can be generated.*

Second: another question now arises — namely, whether it can ever happen, even granting that all the celestial bodies continuously eject and breathe out vapours and exhalations, that they are able to supply so much matter for generating and constituting such immense bodies, namely new stars and comets? Further: supposing that this can happen, will so much depart from those bodies as a result that they necessarily decrease little by little from day to day and appear successively smaller? Especially since new stars and comets are bodies of immense size, as is abundantly clear from Book VI above, pp. 529 and 530, where it was demonstrated that the comet of the year 1652 was four times larger than the Moon in respect of the area of its disc — to say nothing of the new stars, as being round bodies, and to set before our eyes only that single one which shone in Cassiopeia in the year 1572 and, as Tycho attests concerning that same star at p. 485 and p. 549, exceeded the bulk of the Earth three hundred times — according, mind you, to the Tychonic hypothesis; but

according to ours and that of the Copernicans, it was indeed far larger even then?

[Margin: Quantæ fuerit magnitudinis nova Stella in Caſſiopeâ anno 1572.] *How large the new star in Cassiopeia in the year 1572 was.*

We answer that the celestial bodies can by all means exhale and breathe out matter so very copious, or such abundant exhalations and vapours, that such very vast adventitious bodies can be generated; and that nothing whatever departs from those bodies as a result, nor do they incur any detriment or decrease. For this generation is only a circle of nature, as Aristotle says (*De Mundo*, chapter 5): while some parts are ejected, others are preserved for a time, and others are taken back; and so there is there, as it were, a perpetual succession of things, just as here on the Earth and in our sublunary things, where unceasingly some things arise, while others set and perish.

[Margin: Vt circa Terram, ſic circa corpora ætherea indeſinenter alia oriuntur, alia occidunt.] *As around the Earth, so around the ethereal bodies, some things unceasingly arise and others set.*

And that very thing which Aristotle, in the same chapter cited, attributes to sublunary things belongs by the best right, I think, to ethereal things: *"Since meanwhile,"* he says, *"births check rampant deaths, and the deaths of things in turn relieve overflowing births. But the single safety, compounded out of them all, itself remains for ever: since, as things stand opposed to one another and in turn give way and prevail, the universe is preserved for all time, contracting no harm."*

[Margin: Etiamſi in partibus detur generatio & corruptio, totum tamen in æternum conſervatur.] *Even if there is generation and corruption in the parts, the whole is nevertheless preserved for ever.*

For who does not know that from the Earth, day by day, an enormous quantity of vapours and exhalations is expelled and ejected, and has flowed out continuously since the beginning of the world — from which clouds, rain, hail, snow, lightning, thunder and all the other meteors (among which the Peripatetics also count the comets themselves) have arisen — and that nonetheless the Earth has not decreased on that account, nor has anything been lost from the waters, nor, as Aristotle rightly says, has it contracted any harm, still less is any detriment from this detected up to now?

[Margin: Terra licet immenſos vapores & exhalationes continuò emiſerit, nullam tamen contraxit noxam.] *Although the Earth has continually emitted immense vapours and exhalations, it has nevertheless contracted no harm.*

Much less do those very vast ethereal bodies, which exceed our Earth in bulk so many times over, suffer either any detriment or any decrease from this — as much in respect of quality as of substance, or of apparent diameter. Again, the more evaporations and exhalations so many immense bodies, exceeding our Earth so many times over, can breathe out and emit, the more easily and quickly some adventitious body can be coagulated from them.

[Margin: Corpora ætherea univerſa, plus materiæ, quàm Terrâ ejiciunt & exſpirant.] *All the ethereal bodies eject and breathe out more matter than the Earth.*

For the individual planets, too, not infrequently contribute their own [share] to a comet; and the Earth as well brings to it its own most subtle breaths, far thinner than the twilight matter, as we did not deny above. But above all, the companions of Jupiter and the attendants of Saturn, together with the newly detected companion, promote the generation of comets not a little. Since these are very large bodies, they also continually thrust out very many exhalations. How large the individual planets really are — and indeed according to the opinion of various authors — the following table clearly shows. It contains not only the volumes of the bodies, from the distances and diameters, but also the ratios of the diameters and volumes of the planets to the Earth.

[Margin: Quantæ magnitudinis ſint brachiaSaturni, nec non Comes ejus, atq; Circum-Joviales.] *How large the arms of Saturn are, and also its companion, and the Circumjovials.*

Table showing the size of the planets and their ratio to the Earth [TABULA magnitudinem Planetarum & rationem eorum ad Terram exhibens.]

Planet	Names of the authors	Distance of the planets from the Earth	Apparent diameters	True diameter	Circumference of the circular disc	Ratio of the diameter of the Earth to the diameter of the planet
		Semid. Ter.	*Min. Sec.*	*Mill.Germ.*	*Mill.Germ.*	
Sun	Ptolemy	1168	32′ 18″	9438	29650	1 — 5 1/2
	Copernicus	1142	32′ 44″	9351	29380	1 — 5 3/7
	Tycho Brahe	1150	31′ 0″	8918	28020	1 — 5 1/5
	Kepler	3469	30′ 0″	26030	81790	1 — 15
	Boulliau	1460	32′ 52″	12000	37710	1 — 7
	Riccioli	7327	31′ 56″	58530	183900	1 — 34
	Hevelius	5157	31′ 54″	41150	129300	1 — 24
Moon	Ptolemy	59	33′ 20″	492	1546	3 1/2 — 1
	Copernicus	60 1/3	32′ 49″	495	1555	3 1/2 — 1
	Tycho Brahe	56 1/2	34′ 0″	480	1510	3 4/7 — 1
	Kepler	59	30′ 0″	442	1389	4 — 1
	Boulliau	59	32′ 35″	481	1513	3 4/7 — 1
	Riccioli	59	30′ 37″	452	1419	3 4/5 — 1
	Hevelius	59	30′ 0″	442	1389	4 — 1
Saturn	al-Battānī and the hypothesis of Ptolemy	15800	1′ 48″	7088	22270	1 — 4 1/8
	Copernicus	10480	1′ 50″	4768	14980	1 — 3
	Tycho Brahe	10550	1′ 50″	4839	15200	1 — 3
	Kepler	32407	0′ 27″	3643	11445	1 — 2 1/8
	Boulliau	13930	1′ 50″	6390	20070	1 — 3 2/3
	Riccioli	73000	0′ 31″	9435	29640	1 — 5 1/2
	Hevelius	49040	0′ 16″	3362	7945	1 — 2
Jupiter	al-Battānī and Ptolemy	10420	2′ 40″	7020	22050	1 — 4
	Copernicus	5960	2′ 45″	4063	12760	1 — 2 1/3
	Tycho Brahe	5979	2′ 45″	4088	12840	1 — 2 3/8

Planet	Names of the authors	Distance of the planets from the Earth	Apparent diameters	True diameter	Circumference of the circular disc	Ratio of the diameter of the Earth to the diameter of the planet
	Kepler	17720	0′ 40″	2980	9363	1 — 1 3/4
	Boulliau	7628	2′ 45″	5216	16385	1 — 3
	Riccioli	36500	0′ 50″	7609	23900	1 — 4 2/5
	Hevelius	26815	0′ 18″	2054	6455	1 — 1 1/5
Mars	al-Battānī and Ptolemy	4584	1′ 36″	1852	5820	1 — 1 1/13
	Copernicus	1736	1′ 40″	710	2232	2 3/7 — 1
	Tycho Brahe	1745	1′ 40″	713	2240	2 3/7 — 1
	Kepler	5142	1′ 32″	1979	6216	1 — 1 1/7
	Boulliau	2224	1′ 40″	927	2913	6 2/5 — 1
	Riccioli	11000	0′ 32″	1009	3170	1 7/10 — 1
	Hevelius	7855	0′ 5″	160	503	1 5/8 — 1
Venus	al-Battānī and Ptolemy	618	3′ 10″	500	1569	3 1/2 — 1
	Copernicus	1142	3′ 18″	935	2938	1 5/6 — 1
	Tycho Brahe	1150	3′ 15″	930	2922	1 5/6 — 1
	Kepler	3408	1′ 48″	1544	4851	1 3/8 — 1
	Boulliau	1460	3′ 15″	1181	3747	1 1/2 — 1
	Riccioli	7418	1′ 4″	1980	6219	1 — 1 1/7
	Hevelius	5157	0′ 17″	360	1131	4 3/4 — 1
Mercury	al-Battānī and Ptolemy	115	2′ 8″	62	195	27 3/4 — 1
	Copernicus	1142	2′ 12″	623	1958	2 3/4 — 1
	Tycho Brahe	1150	2′ 10″	623	1958	2 3/4 — 1
	Kepler	3408	1′ 28″	1252	3932	1 1/3 — 1
	Boulliau	1460	2′ 10″	791	2486	2 1/6 — 1
	Riccioli	7473	0′ 14″	436	1370	4 — 1
	Hevelius	5157	0′ 6″	130	409	13 — 1

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Table showing the size of the planets and their ratio to the Earth
[TABULA Magnitudinem Planetarum & rationem eorum ad Terram exhibens.]

[549] the table fills the page in one ruled frame below its title. The planet names (Sol, Luna, Saturnus, Jupiter, Mars, Venus, Mercurius) are set sideways in the first column, each centred on its block of seven rows; here each is given in its block's first row, and a rule divides the blocks. The column headings are set in two tiers, the quantity above and its unit below, the unit row given here in italics as printed; the first column carries no heading, and the last no unit. The apparent diameters are printed in two columns under one heading, minutes and seconds, given here as one value. In the last column each ratio is two figures joined by a printed rule, the Earth's diameter first; a 1 standing first means the planet is the larger, a 1 standing second that the Earth is. The authors' names are printed in Latin: Ptolemæus, Copernicus, Tycho Brahe, Keplerus, Bullialdus, Ricciolus, Hevelius, and in the planet blocks "Albategn. & hyp.Ptol." (Saturn) and "Albategnius & Ptol." (Jupiter to Mercury).

Planet	Authors	Area of the greatest circle in the globe	Convex surface of the planetary globe	Solidity of the planetary body	Ratio of the solidity of the terrestrial globe to the solidity of the planetary globe
		Mill. Quadr.	*Milliar. Quadr.*	*Milliar. Cubica.*	
Sun	Ptolemy	69960000	279840000	4401870000001	— 165
	Copernicus	68680000	274730000	4281870000001	— 160
	Tycho Brahe	62470000	249880000	3714110000001	— 140
	Kepler	532450000	2129800000	92399000000001	— 3469
	Boulliau	113175000	452700000	9057090000001	— 340
	Riccioli	2691000000	10764000000	1050021000000000	39436
	Hevelius	1330000000	5320000000	364948000000000	13604
Moon	Ptolemy	190100	760400	62354000	43 — 1
	Copernicus	192500	770000	63530000	42 — 1
	Tycho Brahe	181400	725600	58040000	46 — 1
	Kepler	153500	614000	45225000	59 — 1
	Boulliau	182100	728400	58440000	46 — 1
	Riccioli	160200	640800	48230000	55 — 1
	Hevelius	153500	614000	45225000	59 — 1
Saturn	Ptolemy and al-Battānī	39460000	157840000	18646900000001	— 70
	Copernicus	17850000	71410000	56759000000	1 — 21 1/3
	Tycho Brahe	18390000	73560000	58723000000	1 — 22
	Kepler	10530000	42120000	25320000000	1 — 9 1/2
	Boulliau	35430000	141720000	136553000000	1 — 51
	Riccioli	77280000	309120000	43983000000001	— 166
	Hevelius	5020608	20082432	8461398016	1 — 3 1/7
Jupiter	Ptolemy and al-Battānī	387000000	154800000	181106000000	1 — 68
	Copernicus	12965000	51860000	35113000000	1 — 13
	Tycho Brahe	13130000	52520000	35780000000	1 — 13 1/2
	Kepler	6976000	27904000	13860000000	1 — 5 1/2
	Boulliau	21360000	85440000	49803000000	1 — 19
	Riccioli	45470000	181880000	23067200000001	— 86
	Hevelius	3314129	13265651	4538148680	1 — 1 3/4
Mars	Ptolemy and al-Battānī	2695000	10780000	3328500000	1 — 1 1/4
	Copernicus	396700	1586800	188000000	14 — 1
	Tycho Brahe	399400	1597600	189900000	14 — 1

Planet	Authors	Area of the greatest circle in the globe	Convex surface of the planetary globe	Solidity of the planetary body	Ratio of the solidity of the terrestrial globe to the solidity of the planetary globe
	Kepler	3075000	12300000	4055000000	1 — 1 1/2
	Boulliau	675300	2701200	417500000	6 2/5 — 1
	Riccioli	799600	3198400	537900000	5 — 1
	Hevelius	20080	80320	2141760	1241 8/11 — 1
Venus	Ptolemy and al-Battānī	195900	783600	65240000	40 — 1
	Copernicus	686800	2747400	428100000	6 — 1
	Tycho Brahe	679600	2718400	421400000	6 — 1
	Kepler	1873000	7492000	1928000000	1 1/8 — 1
	Boulliau	1095000	4380000	862300000	3 — 1
	Riccioli	3108000	12432000	4061000000	1 — 1 1/2
	Hevelius	101700	406800	24408000	109 — 1
Mercury	Ptolemy and al-Battānī	3012	12048	124400	21400 — 1
	Copernicus	305200	1220800	126900000	20 — 1
	Tycho Brahe	305200	1220800	126800000	20 — 1
	Kepler	1230000	4920000	1033000000	2 1/2 — 1
	Boulliau	491800	1967200	259500000	10 — 1
	Riccioli	149500	598000	43460000	62 — 1
	Hevelius	13260	53040	1149200	2315 — 1

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Now it will also serve our purpose to add how great the attendants [laterones] and the companion of Saturn are, and likewise the Circumjovials, both with respect to us and with respect to Saturn and Jupiter, as regards visible diameter and solidity. You will find all of these, carefully computed by us, in the following small tables, and indeed according both to Kepler's hypothesis and to ours. In our hypothesis the Sun, and so also Saturn and Jupiter, are removed farther from the Earth by quite a notable interval, yet somewhat less than

[550] the table fills the page in one ruled frame below its title, which repeats that of the previous page; it continues the previous page's table for the same planets and authors in the same order. The planet names (Sol, Luna, Saturnus, Iupiter, Mars, Venus, Mercurius) are set sideways in the first column, each centred on its block of seven rows; here each is given in its block's first row, and a rule divides the blocks. The column headings are set in two tiers, the quantity above and its unit below, the unit row given here in italics as printed; the first column carries no heading, and the last no unit. In the last column each ratio is two figures joined by a printed rule, the Earth's solidity first. The authors' names are printed in Latin as on the previous page, but the first name of each planet block from Saturn on reads "Ptolem. & Albategn.", Ptolemy first.

according to Riccioli. For our parallax is set at about 40″, but Riccioli's at only 28″. Hence our mean distance of the Sun from the Earth comes to 5160 semidiameters of the Earth [S. T.], Riccioli's being 7300 S. T., whereas Kepler's mean is only 3410 S. T.

[Margin: Quanto intervallo Sol à Terrâ diſtet.] *How great an interval separates the Sun from the Earth.*

I. Magnitudes of the companions of Saturn and Jupiter [I. COMITUM SATURNI ET JOVIS MAGNITUDINES.]

	Circum-Saturnian	Circum-Jovial	Circum-Saturnian	Circum-Jovial	
	According to Kepler's hypothesis		*According to our hypothesis*		
Mean distance from the Earth	32400	17720	49000	26800	*Semid.* ♁
Diameter apparent from the Earth	0′ 1″	0′ 2″	0′ 1″	0′ 2″	*Min. & Secund.*
True diameter	135	148	205	224	*Milliar.*
Circumference of the greatest disc	425	464	642	700	*Milliar.*
Area of the greatest circle	14340	17150	32835	39270	*Mill. Quadrat.*
Convex surface	57360	68600	131340	157080	*Mill. Quadrat.*
Solidity of the globe	1292000	1689000	4476000	5854000	*Mill. Cubic.*
Ratio of the diameter of the Earth to the diameter	12 3/4 — 1	11 3/5 — 1	8 2/5 — 1	7 2/5 — 1	
Ratio of the solidity of the Earth to the solidity	2064 — 1	1530 — 1	592 — 1	455 — 1	

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II. Table showing the distances of the companions from Saturn and Jupiter, together with their diameters as seen from Saturn and Jupiter [II. Tabula exhibens Diſtantias Comitum à Saturno & Jove, unà cum diametris illorum ex Saturno & Jove apparentibus.]

[551]the table stands below the prose, in one ruled frame. The first column carries the row labels and no heading; the last carries the units, printed in italics and given here as printed, and no heading. Columns two and three stand under the heading "According to Kepler's hypothesis" [Juxta Hypotheſin Kepleri.], columns four and five under "According to our hypothesis" [Juxta Hypotheſin Noſtram.]; each heading is given here in the second row, over the first of its two columns. The Earth is written in the labels and units with its sign, ♁. The apparent diameters are printed as two figures, minutes and seconds, given here as one value. In the last two rows each ratio is two figures joined by a printed rule, the Earth's figure first.

	Distance from its planet, apparent on the Earth	Distance from its centre in semidiameters of the Earth	Distance from its centre in miles	True diameter in miles	Diameter apparent from its centre	Distance from its centre, apparent on the Earth	Distance from its centre in semidiameters of the Earth	Distance from its centre in miles	True diameter in miles	Diameter apparent from its centre
	According to the Keplerian hypothesis					*According to our hypothesis*				
	Min. Sec.				*Min. Se.*	*Min. Sec.*				*Min. Se.*
Circum-Saturnian	2′ 0″	28	24320	135	19′ 6″	3′ 0″	43	36800	205	19′ 6″
Circum-Jovial	2′ 0″	15 1/2	13300	148	38′ 12″	3′ 0″	23 1/3	20120	224	38′ 12″
I										
II	5′ 0″	26	22160	148	22′ 56″	5′ 0″	39	34900	224	22′ 56″
III	8′ 0″	41	35460	148	14′ 20″	8′ 0″	62	53660	224	14′ 20″
IV	14′ 0″	72	62060	148	8′ 10″	14′ 0″	110	93910	224	8′ 10″

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III. Table showing the size of Saturn and of the attendants, or its arms [III. Tabula exhibens magnitudinem Saturni & Lateronum, ſeu brachiorum ejus.]

	According to Kepler's hypothesis	According to our hypothesis	
Least distance of Saturn from the Earth	27100	41000	*Semid.* ♄
Longest diameter of Saturn, apparent	1′ 12″	1′ 12″	*Min. & Secund.*
True	8135	12310	*Milliar.*
Interval between the arms of Saturn, apparent	0′ 52″	0′ 52″	*Min. & Secund.*
True	5875	8890	*Milliar.*
Breadth of one arm, apparent	0′ 10″	0′ 10″	*Min. & Secund.*
Breadth of one arm, true	1130	1710	*Milliar.*
Shortest diameter of Saturn, apparent	0′ 34″	0′ 34″	*Min. & Secund.*
True	3842	5812	*Milliar.*

[552] the table stands below the first, in one ruled frame. The first column carries the row labels and no heading. The first five columns of figures stand under the heading "According to the Keplerian hypothesis" [Juxta hypotheſin Keplerianam.], the last five under "According to our hypothesis" [Juxta hypotheſin Noſtram.]; each heading is given here in the second row, over the first of its columns. The units are printed below the headings in four columns only, and are given in the third row in italics as printed. The angles are printed as two figures, minutes and seconds, given here as one value. The four Jovian companions are numbered I–IV, I on the line of "Circum-Jovial", II–IV alone below it.

	According to Kepler's hypothesis	According to our hypothesis	
Circumference of the middle circle	12070	18260	*Milliar.*
Area of the middle circle	11590000	26530000	*Mill. Quadr.*
Solidity of the whole of Saturn with the arms	62865000000	217700000000	*Mill. Cubic.*
Solidity of Saturn without the arms	45400000000	157200000000	*Mill. Cubic.*
Solidity of one arm	8732000000	30250000000	*Mill. Cubic.*
Ratio of the diameter of the Earth to the longest diameter of Saturn	11 — 4 3/4	1 — 7 1/6	
Ratio of the diameter of the Earth to the shortest diameter of Saturn	1 — 2 1/4	1 — 3 3/8	
Ratio of the solidity of the Earth to the solidity of Saturn	1 — 24	1 — 59	
Ratio of the solidity of the Earth to the solidity of an arm	1 — 3 1/3	1 — 11	

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IV. Table of the apparent diameters of the Sun, as if seen from the Earth and the other primary planets, at their mean distances from the Sun [IV. TABULA APPARENTIUM DIAMETRORUM SOLIS, Ex Terrâ & Reliquis Planetis primariis quaſi ſpectati, ad diſtantias ipſorum à Sole Medias.]

Authors	From Saturn	From Jupiter	From Mars	From the Earth	From Venus	From Mercury
	Min. Sec.	*Min. Sec.*	*Min. Sec.*	*Min. Sec.*	*Grad. Min. Sec.*	*Grad. Min. Sec.*
Ptolemy and al-Battānī	2′ 24″	3′ 38″	8′ 14″	32′ 18″	1° 8′ 40″	0° 35′ 50″
Copernicus	3′ 34″	6′ 16″	21′ 4″	32′ 44″	0° 45′ 30″	1° 31′ 38″
Tycho Brahe	3′ 22″	5′ 56″	20′ 26″	31′ 0″	0° 43′ 6″	1° 26′ 52″
Kepler	3′ 14″	5′ 52″	20′ 14″	30′ 32″	0° 42′ 10″	1° 18′ 40″
Boulliau	3′ 26″	6′ 18″	21′ 34″	32′ 52″	0° 45′ 24″	1° 25′ 12″
Riccioli	3′ 12″	6′ 24″	21′ 16″	31′ 56″	0° 44′ 12″	1° 22′ 46″
Hevelius	3′ 22″	6′ 8″	20′ 56″	31′ 54″	0° 44′ 4″	1° 22′ 12″

553 the table stands below the second, in one ruled frame, and fills the page to the foot. The first column carries the row labels and no heading, the last the units in italics as printed and no heading. Where a label reads only "True" [Vera. / Verum.], it is printed under the "Apparent" of the line above and belongs to the same quantity. The apparent angles are printed as two figures, minutes and seconds, given here as one value. In the last four rows each ratio is two figures joined by a printed rule, the Earth's figure first. In the ratio of the diameters for Kepler's hypothesis the page prints 11 before the rule, where the other ratios of this table print 1.

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V. Table of the apparent diameter of the Earth, as if seen from the planets at their mean distance from it [V. TABULA APPARENTIS DIAMETRI TERRÆ Ex Planetis, mediocriter ab ipsâ diſtantibus quaſi ſpectatæ.]

Authors	From the Sun	From the Moon	From Saturn	From Jupiter	From Mars	From Venus	From Mercury
	Min. Sec.	*Gr. Mi. Se.*	*Min. Sec.*	*Min. Sec.*	*Min. Sec.*	*Min. Sec.*	*Min. Sec.*
Ptolemy and al-Battānī	5′ 53″	1° 56′ 32″	0′ 26″	0′ 39″	1′ 30″	11′ 8″	59′ 48″
Copernicus	6′ 1″	1° 53′ 58″	0′ 39″	1′ 9″	3′ 58″	6′ 1″	6′ 1″
Tycho Brahe	5′ 59″	2° 1′ 40″	0′ 39″	1′ 9″	3′ 56″	5′ 59″	5′ 59″
Kepler	2′ 1″	2° 1′ 50″	0′ 13″	0′ 23″	1′ 20″	2′ 1″	2′ 1″
Boulliau	4′ 43″	1° 56′ 20″	0′ 30″	1′ 0″	3′ 5″	4′ 43″	4′ 43″
Riccioli	0′ 56″	1° 56′ 32″	0′ 6″	0′ 11″	0′ 37″	0′ 56″	0′ 56″
Hevelius	1′ 20″	2° 1′ 50″	0′ 8″	0′ 15″	0′ 53″	1′ 20″	1′ 20″

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From these it is abundantly clear that, even though the diameter of the Jovials appears, with respect to us, of small magnitude, namely of two seconds, and the Saturnian diameter of scarcely one second, their true diameter nevertheless runs, according to the Keplerian hypothesis, to 148, and according to ours even to 224 German miles; hence their solidity grows immensely. Considered from Jupiter, therefore, they are outstanding and very conspicuous bodies. For the first of the Jovials in order appears there, as regards apparent diameter, larger than the Moon, and indeed even than the Sun itself, appears to us. The diameter of each luminary is only 30′, more or less, whereas that of the first companion, seen from Jupiter, is estimated at 38′ 12″. The second in order, seen, that is, from Jupiter at 22′ 56″, is there scarcely a little smaller than the Moon itself is to us. The third Jovial, at a size of 14″ 20″, almost equals the Moon when halved [biſectam]. The fourth, because it amounts to 8′ 10″, sometimes even outdoes Venus at perigee. These things clearly show that Jupiter is a notable and splendid globe, accompanied by four Moons that continually undergo various changes, and indeed with so very swift a motion that the first Jovial goes round Jupiter in the space of 14 days, the second in 8, the third in 5, and the fourth in an interval of three days, whereas our Moon completes its period

554this table and the next stand in one ruled frame at the head of the page. The planets are printed in the column headings by their signs (♄, ♃, ♂, ♁, ♀, ☿), given here by name. The units, printed below the headings, are given in the second row in italics as printed; each value is printed as two or three figures, given here as one. The column "From the Earth" repeats the Sun's apparent diameters of the table of planetary sizes two pages earlier, except in Kepler's row, which there reads 30′ 0″.

555the title of this table is set inside the frame it shares with table IV. The Sun, the Moon and the planets are printed in the column headings by their signs (☉, ☽, ♄, ♃, ♂, ♀, ☿), given here by name. Units as printed in the second row, values given as one.

around the Earth only in a whole month. It is therefore most probable from this that far greater changes can occur at Jupiter than here with us by reason of the Moon.

[Margin: Quantæ magnitudinis Jovis Comites, ex Jove conſpecti.] *How large the companions of Jupiter are, seen from Jupiter.*

[Margin: Valde veriſimile eſſe videtur, Jovem longe majoribus mutationibus quàm noſtram Terram eſſe obnoxium.] *It seems very probable that Jupiter is subject to far greater changes than our Earth.*

The size of the apparent diameter of the orbit of each of the planets, if they are imagined to be seen from some fixed star, the parallax of the annual orbit being supposed a whole 10 seconds [Quantitas apparentis diametri Orbis ſingulorum planetarum, ſi ſinguntur conſpici ex aliquâ Stellâ fixâ,ſuppoſitâ parallaxi orbis annui integrâ 10 ſecundorum.]

	Proportions of the orbits		Apparent diameter
Of the fixed stars	41250.000	—	
Saturn	9.510	—	1′ 35″
Jupiter	5.200	—	0′ 52″
Mars	1.523	—	0′ 15″
Earth	1.000	—	0′ 10″
Venus	724	—	0′ 5″
Mercury	388	—	0′ 3″

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Saturn's companion [Saturnalis], moreover, is likewise an outstanding planet. Its true diameter is 205 miles, while its apparent diameter, seen from Saturn, amounts to 19′ 6″; and it stands off from Saturn at almost as great an interval as that at which the Moon, for its part, nearly stands off from the Earth. Again, if the Moon were seen from Jupiter, its apparent diameter would scarcely be 12″, and from Saturn scarcely 6″. Indeed, believe me, the Sun itself would appear, from Jupiter itself, no larger than 6′ 8″, and from Saturn scarcely 3′ 22″, as is clear from table IV of the preceding ones. Add to this that those arms of Saturn, or attendants, clinging closely to its body, contribute not a little to this business.

[556] this table stands in its own ruled box to the right of the narrow column of text, its title inside the box. The planets are printed in the first column by their signs, given here by name; "Of the fixed stars" renders the printed "Fixarum". The figures of the second column are printed with a point in the first five rows and without one in the last two. Each row carries a printed rule between the proportion and the apparent diameter. The apparent diameters are printed as two figures, minutes and seconds, with the marks ′ and ″ printed only in the first row; given here as one value. At 10″ for the Earth's orbit, Venus's 724 and Mercury's 388 would give about 7″ and 4″, where the page prints 5 and 3.

[557] below the two tables the text is set in a narrow column on the left as far as "224 millia-", with the boxed table standing to its right; the sentence runs on below the box across the full width of the page. The prose is given here in one piece, and the boxed table after it.

[Margin: Quantus ſit Saturni Comes, ex Saturno viſus; quantumq́; ab eo diſtet.] *How large Saturn's companion is, seen from Saturn; and how far it stands from it.*

[Margin: Luna & Sol quantæ magnitudinis appareant ex Saturno & Jove.] *How large the Moon and the Sun appear from Saturn and Jupiter.*

Accordingly, there is no reason for us to wonder that so much matter and so many exhalations can, over the course of a longer time, be drawn out and exhaled, as much by the force of the Sun's rays as by that of the other bodies, from those seven primary [planets], as well as from the five lesser secondary ones and also from the two attendants of Saturn, that a comet can sometimes be generated from them. Above all, since not so much matter is required for such disc-shaped bodies as for wholly spherical ones. Rather, we certainly cannot help wondering how it can ever happen that from one single and so slender a body, namely our Earth, whose diameter seen from the other planets appears to be scarcely a few seconds, as the last of the preceding tables attests, and which is thus of almost no importance with respect to the other ethereal bodies, so great an abundance of exhalations and vapours can be cast out; from which, almost every day, as we know well from experience, so very many meteors are produced.

[Margin: Magis admirandum tot meteora exTerrâ, quàm ex tot corporibus Cœleſtibus nonnullos Cometas generari poſſe.] *It is more to be wondered at that so many meteors can be generated from the Earth than that some comets can be generated from so many celestial bodies.*

And although the Sun, as we touched on above, appears very slender to Saturn and Jupiter, so that, in your opinion, if I am not mistaken, the forces it can exert there in exhaling evaporations are also weak, the satellites of Jupiter and Saturn nonetheless make up for all of that no less vigorously; and above all that whole army of the fixed stars, all of which appear far larger and brighter on Saturn, Jupiter and Mars than here on the terrestrial globe. For the smallest of them all is seen there larger than Venus; but the larger ones, such as Arcturus, Capella, Lyra and Sirius, show at least 8′, 10′, indeed 12′ in diameter. For the fixed stars are immense bodies: the diameter of the smaller ones exceeds the Earth's diameter 1,006 times [millies ſexies], and that of the larger ones, namely of Sirius, 1,012 times [millies duodecies]; so that the solidity of this fixed star is greater than the solidity of the Earth by as much as this number, 15,056,882,800,000, indicates.

[Margin: Fixæ quantæ magnitudinis ex Saturno appareant, etiam reverà exiſtant ratione Terræ.] *How large the fixed stars appear from Saturn, and also how large they really are in relation to the Earth.*

Therefore, since the fixed stars, if searched out with the telescope, are almost innumerable, and moreover by far the most vast masses, there is surely no doubt that new stars are generated without difficulty from the exhalations of so very many fixed stars, and comets from the evaporations of the planets. Indeed, one is moved to wonder why more new stars do not arise. But perhaps a great

many are born which by no means come into view. For, as I conjecture, they rarely reach so great a size that they can be seen by us; *and many*, thus, *go by in secret* (as Seneca says in Book VII of the *Natural Questions*), *never rising before human eyes*. Without doubt many also rise every year, and set again, among the smallest ones, which are perceived only with the tube, especially in the Milky Way, where so many myriads of the tiniest stars occur; of these nothing whatever becomes known to the human race, nor can it ever even become known: for in no

[Margin: Posſe longè plures Cometas procreari, quàm quidem hactenus obſervati ſunt; & quare?] *That far more comets can be produced than have so far been observed; and why?*

[Margin: Ex minimis illisFixis ſæpiùs posſe nonnullas oriri ac rursùs occidere, quanquam nullus unquam id deprehenderit.] *That some of those smallest fixed stars can quite often rise and set again, although no one has ever detected it.*

way do we have them counted, as we do indeed have those more notable and larger ones, brought into tables through the most painstaking night-watches and the tireless study of the ancient astronomers. And yet, if one may confess the truth, a great many stars of the fourth, fifth and sixth magnitude are still missing from the globes, wholly neglected and omitted by our predecessors, and also by that supreme astronomer Tycho. Hence, however eagerly the mind strives to attend to new stars, it is nonetheless by no means free to do so, since we still by no means know all the old ones, even those clearly visible to the naked eye.

[Margin: Stellæ Fixæ neutiquam adhuc omnes in certum numerum relatæ ſunt.] *The fixed stars have by no means all yet been brought into a definite number.*

[Margin: Plurimæ veterum affixarum nondum hactenus obſervatæ fuerunt.] *Very many of the old fixed stars have not been observed up to now.*

It would therefore not be a vain labour, in our judgement, though a Herculean one, if all the fixed stars perceptible to the naked eye were observed correctly and in order, so that posterity could be certain of their true place as well as of their true magnitude and genuine colours, and so that it might in future be established with certainty whether some change also occurs with time, both in their number and in their magnitude and colours. Above all, so that it may not remain unknown whether some new little star arises, or whether some other, ancient one perishes. For I am almost convinced that very many new ones are not only kindled quite frequently among those smallest stars of the fifth and sixth magnitude, but also that some old ones change not a little in magnitude in the course of time, and indeed are sometimes extinguished entirely. Taking into account that many are now found not to be of so great a magnitude as Hipparchus and Ptolemy, those by far the most diligent observers, once established. Thus to the Bright Star of Aquila [Lucidæ Aquilæ], that remarkable star which at this time is rightly counted among the stars of the first rank, they assigned the second magnitude; the Bright Star of Aries they placed among the stars of the third magnitude, though it is now of the second; likewise

they made the Second of Aries equal to the First, namely of the fourth, although by the best right it is reckoned among the stars of the third magnitude and is much larger than that First of Aries. This is plain to anyone, to say nothing of the rest, a great many of which are found here and there differing very much indeed from the former standard and from the magnitude assigned to them. On the other hand, others occur which are now seen larger than formerly; among the rest, for example, the preceding star at the cheek of Cetus, which is only of the fourth magnitude, although the ancients recognised it as a star of the third magnitude; and many others of this kind are found, especially among those lesser ones of the fifth and sixth magnitude. Since this is wrongly ascribed to the carelessness of our predecessors, my mind foresees from it that some alteration lies hidden here. Indeed, since this is a matter of great moment, and it greatly concerns the philosopher who searches out heavenly things that this very point should at last be investigated accurately, I have therefore, with God's good help, undertaken this immense work. My intention, namely, was first to measure anew, in longitude and latitude, all those fixed stars which are contained in the catalogue of the ancients and also in Tycho's, but by an entirely new method, as exquisitely as can ever be done, with very large instruments made wholly of solid metal, six, seven, eight and more feet in size as regards the radius; then also to add all the remaining ones, not far below the sixth magnitude, which exist here and there in the heavens and have not yet been entered on globes or in any catalogue; and likewise to note down their magnitudes and colours with the utmost skill, to the best of my ability: so that posterity may at last not be ignorant whether and when some new [star]

[Margin: Valdè rei Aſtronomicæ conduceret, ſi Fixæ omnes nudis oculis deprehẽſibiles, recte obſerventur; & quare?] *It would greatly benefit astronomy if all the fixed stars perceptible to the naked eye were correctly observed; and why?*

[Margin: Nonnullas Fixas quà magnitudinem immutatas eſſe, exemplis & obſervationibus probatur.] *That some fixed stars have changed as regards magnitude is proved by examples and observations.*

[Margin: Cur Autor ſuſceperit cum DEO, novum &locupletiorem Fixarum Catalogum condere; & quidèm novâ ratione?] *Why the author has undertaken, with God, to compile a new and richer catalogue of the fixed stars; and that by a new method.*

comes forth, or whether [one] sets, and also whether they undergo some change. For very many changes in the heavens, *especially in the smaller stars, easily slip past through neglect of observations, and are lost to us*, as Verulam rightly judges, in the *Natur. & Univers. Philos.*, pages 126 and 148. If I learn that this labour will not be unwelcome to the learned, I shall take pains (since that task, with God's grace consenting, is already for the most part completed) that it be published shortly together with our *Machina coelestis*, provided that God, the Best and Greatest, most mercifully grants me life, health and leisure.

[Margin: MachinaCœleſtis Auctoris propediem prælo ſubjicietur.] *The author's Machina coelestis will shortly be put to the press.*

But let us continue on our way. And although we have already shown amply enough that so great a quantity of matter can certainly be evaporated and cast out from the fixed stars for some new star, and from the planets for a comet, I will nevertheless derive this still more clearly and demonstrate it as if with a finger, so that no lover of the truth will be able to retort anything at all in future: namely, that the Sun alone can belch forth and emit matter in so great an abundance as to be sufficient, not only after some years have passed for a single comet, but also for generating several, even supposing their diameters to be no smaller than the Moon's diameter; and that indeed in a very short space of time, namely of some months — what am I saying? — of weeks. So much so that in one year more matter is expired from the Sun than is needed to generate very many comets, however much each of them be supposed wholly equal to our most recent comet, of the year 1652, or to the one Seneca mentions in Book VII of the *Natural Questions*, with a diameter no smaller than the Sun's.

[Margin: Ex ſolo Sole plurimi Cometæ unico anno generari poſſunt.] *From the Sun alone very many comets can be generated in a single year.*

To begin with, from very many and by far most accurate observations of sunspots, Scheiner's as well as our own, we have learned abundantly that those spots appearing about the Sun are of different magnitudes: most of them amount to 1/40, 1/35, 1/30 part of the Sun's diameter; others in turn, namely the larger ones, equal 1/62, 1/12 and 1/18 part of the said diameter of the Sun. But the shadows and faculae are usually much larger as regards their diameter (the longer one, understand). For sometimes some tracts of shadows and faculae extend to 1/10, 1/7, 1/5, indeed to a third of the Sun's diameter (such as appeared in 1643 on July 20 and August 21, and were noted by us in the *Selenographia*). The nuclei, however, that is, the denser parts of the spots, quite often occupy one hundredth part, indeed one fiftieth, of the Sun's diameter; so that, to put it briefly, they are huge and wonderful bodies. Moreover, it almost surpasses human understanding how so much matter, and so many exhalations and vapours, could ever burst forth and be produced from that single body of the Sun, by which such very vast phenomena can be brought forth. The true diameter of their nuclei, when it is given as 1/50 part of the Sun's diameter and Kepler's distance of the Sun from the Earth is taken into account, turns out greater than the Moon's diameter; while the larger spots, equalling 1/18 part of the Sun's diameter, come close to almost the Earth's diameter, namely according to our distance of the Sun from the Earth; and this although you set the apparent diameter of the smaller spots at only a few seconds, and that of the larger at 1′ 47″.

[Margin: Quantæ m[[a/á]]gnitudinis reſpectu Solis ſint maculæ, faculæ, & umbræ Solares.] *How large the solar spots, faculae and shadows are in relation to the Sun.*

[Margin: Sunt immenſa, ac penitùs admiranda corpora.] *They are immense and wholly wonderful bodies.*

[Margin: Maculæ nonnullæ ratione diametri,Lunam & Terram excedunt.] *Some spots exceed the Moon and the Earth as regards diameter.*

But if these bodies, keeping the same magnitude, were placed in a location nearer the Earth, where comets sometimes travel — for example at only 110 semidiameters of the Earth, where the comet of the year 1652 stood at first; or somewhat closer still, where the comet of the year 1618 was seen on December 1 and 9, at 96 or 72 semidiameters of the Earth; but above all if they were set no farther off than the Moon, at 60 semidiameters of the Earth — O, by the immortal God, how wonderfully large these bodies would be as regards their apparent diameter! For a single nucleus containing 1/50 part of the Sun's diameter would equal the Moon at a distance of 110 semidiameters of the Earth, and at a remove of 60 semidiameters from the Earth would appear twice as large as the Moon. And those larger ones, taking up an eighteenth part of the Sun's diameter, would be seen at the former distance of 110 semidiameters of the Earth under an angle of 1° 24′ 26″, and at the latter, nearer elongation from the Earth under an angle of 2° 34′ 50″. Since all these things really are so (although to the Peripatetic school they may seem scarcely probable), they certainly deserve, as matters that open the doors to far more abstruse philosophical speculations, that whatever we have just said be computed correctly and accurately, and that it be clearly demonstrated to anyone both what the true diameter of the spots, faculae and nuclei is for those distinct magnitudes, and also how great their area of the great circle is, together with the apparent diameter at various distances below the Sun.

[Margin: Quâ facie, & magnitudine maculæSolares apparerent, ſi nobis viciniores, ad diſtantiam ſc. Lunæ, darentur.] *With what appearance and size the sunspots would appear if they were set nearer to us, namely at the distance of the Moon.*

[Margin: Magnitudo apparentis diametri Macularum in diverſis àTerrâ diſtantiis, in Tabellâ exhibita.] *The size of the apparent diameter of the spots at various distances from the Earth, shown in a little table.*

For the good of philosophy, I have entered all this in the following little table, leaving out entirely all the lengthy and most tedious calculation, according both to Kepler's and to our own mean distance of the Sun from the Earth. In the first column you will have the ratio of the spots, nuclei and shadows to the Sun's diameter; in the second column the apparent diameter of the spots, in minutes and seconds; in the third the true diameter; in the fourth the area of the circular disc; and in the four following the apparent diameter at various distances, namely according to Kepler's hypothesis. Lastly, in the remaining ones, all these are shown according to our own [hypothesis].

	Ratio of the diameter of the spots to the Sun's diameter	Apparent diameter of the sunspot	True diameter of the sunspots	Area of the circular disc, or of the great circle	At 60 semidiameters of the Earth	At 72 semidiameters of the Earth	At 96 semidiameters of the Earth	At 110 semidiameters of the Earth
	32 Min.	*Mi.Sec.*	*Mill.Germ.*	*Mill. Quad.*	*Gr.M.Sec.*	*Gr. Mi. Se.*	*Gr.Mi. Se.*	*Gr.Mi. Se.*
Nucleus	1 — 100	0′ 19″	256	51470	0° 17′ 2″	0° 14′ 12″	0° 10′ 40″	0° 9′ 18″
Nucleus	1 — 50	0′ 38″	540	229000	0° 36′ 0″	0° 30′ 0″	0° 22′ 30″	0° 19′ 38″
Spot	1 — 40	0′ 48″	682	365300	0° 45′ 28″	0° 37′ 54″	0° 28′ 25″	0° 24′ 48″
Spot	1 — 35	0′ 55″	768	463200	0° 51′ 10″	0° 42′ 40″	0° 31′ 58″	0° 27′ 54″
Spot	1 — 30	1′ 4″	910	650400	1° 0′ 38″	0° 50′ 30″	0° 37′ 54″	0° 33′ 4″
Spot	1 — 26	1′ 14″	1052	869200	1° 10′ 6″	0° 58′ 24″	0° 43′ 50″	0° 38′ 2″
Spot	1 — 22	1′ 28″	1252	1231000	1° 23′ 20″	1° 9′ 28″	0° 52′ 6″	0° 45′ 28″
Spot	1 — 18	1′ 47″	1536	1853000	1° 42′ 10″	1° 25′ 16″	1° 3′ 56″	0° 55′ 48″
Faculae and shadows	1 — 10	3′ 12″	2730	5854000	3° 5′ 40″	2° 31′ 40″	1° 53′ 40″	1° 39′ 12″
Faculae and shadows	1 — 7	4′ 34″	3896	13175000	4° 19′ 40″	3° 36′ 10″	2° 42′ 10″	2° 21′ 40″
Faculae and shadows	1 — 5	6′ 24″	5460	23413000	6° 3′ 30″	5° 3′ 0″	3° 47′ 20″	3° 18′ 20″
Faculae and shadows	1 — 3	10′ 40″	9100	65050000	9° 59′ 30″	8° 24′ 20″	6° 18′ 30″	5° 30′ 20″

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[558] the table stands below the prose in one ruled frame, with no title of its own. The first column carries the row labels and no heading. The columns from the true diameter onward stand under the heading "At the mean distance of the Sun from the Earth of 3410 semidiameters of the Earth, according to Kepler's hypothesis" [Ad diſtantiam Solis à Terrâ Mediam 3410 Semid.Terræ. Juxta Hypoth. Kepler.]; the box above the first three columns is empty. The last four columns stand under the further heading "Apparent diameters of the spots, if their distance from the Earth is set at" [Diametri Apparentes Macular. ſi ſtatuatur ipſarum diſtantia à Terrâ.], each column then headed by its distance, printed "60 S.T.", "72 S.T.", "96 S.T." and "110 S.T.". The Sun is printed in the second and third headings by its sign. The units, printed below the headings, are given in the second row in italics as printed; each value printed as two or three figures is given here as one. The ratio is printed as 1, a long rule and the denominator. Rules divide the rows into four groups of three. No label row stands below the last row of figures.

	Ratio of the diameter of the spots to the Sun's diameter	Apparent diameter of the sunspot	True diameter of the sunspots	Area of the circular disc of the spots	At 60 semidiameters of the Earth	At 72 semidiameters of the Earth	At 96 semidiameters of the Earth	At 110 semidiameters of the Earth
	32 Min.	*Mi.Sec.*	*Mill.Germ.*	*Mill. Quad.*	*Gr.M. Sec.*	*Gr. Mi. Se.*	*Gr.Mi. Se.*	*Gr.Mi. Se.*
Nucleus	1 — 100	0′ 19″	388	118200	0° 25′ 48″	0° 21′ 30″	0° 16′ 8″	0° 14′ 4″
Nucleus	1 — 50	0′ 38″	818	525500	0° 54′ 28″	0° 45′ 25″	0° 34′ 2″	0° 29′ 42″
Spot	1 — 40	0′ 48″	1032	836500	1° 8′ 48″	0° 57′ 20″	0° 43′ 0″	0° 37′ 32″
Spot	1 — 35	0′ 55″	1160	1057000	1° 17′ 24″	1° 4′ 30″	0° 48′ 22″	0° 42′ 14″
Spot	1 — 30	1′ 4″	1376	1487000	1° 31′ 44″	1° 16′ 26″	0° 57′ 20″	0° 50′ 2″
Spot	1 — 26	1′ 14″	1590	1986000	1° 45′ 58″	1° 28′ 20″	1° 6′ 14″	0° 57′ 48″
Spot	1 — 22	1′ 28″	1894	2817000	2° 6′ 10″	1° 45′ 6″	1° 18′ 50″	1° 8′ 48″
Spot	1 — 18	1′ 47″	2324	4241000	2° 34′ 50″	2° 9′ 0″	1° 36′ 45″	1° 24′ 26″
Faculae and shadows	1 — 10	3′ 12″	4130	13400000	4° 35′ 0″	3° 49′ 20″	2° 52′ 0″	2° 30′ 0″
Faculae and shadows	1 — 7	4′ 34″	5894	27280000	6° 32′ 20″	5° 27′ 0″	4° 5′ 20″	3° 34′ 10″
Faculae and shadows	1 — 5	6′ 24″	8260	53590000	9° 9′ 20″	7° 38′ 0″	5° 43′ 40″	5° 0′ 0″
Faculae and shadows	1 — 3	10′ 40″	13770	148900000	15° 12′ 0″	12° 41′ 20″	9° 32′ 0″	8° 19′ 30″

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You will therefore understand, with hardly any trouble, how admirable and astonishing a magnitude these very bodies display. The most common of them, which take up one fortieth part of the Sun's diameter, contain 1032 German miles in true diameter; that is, they are twice as large as the Moon's diameter. The diameter of the larger ones, however, comes to 2324 German miles, and so they exceed the diameter of the Earth. Further, those tracts of shadows and faculae: their length is sometimes eight times greater than the Earth's.

[Margin: Quanta ſit vera diameter minorum & majorum Macularum Solarium.] *How great the true diameter of the smaller and the larger sunspots is.*

Therefore all the more judicious philosophers will admit with me that an almost incredible abundance of exhalations and of smoky evaporations is needed to generate bodies of this kind, as is plain from the table. Now the Sun alone is able to supply from its own body so much matter for producing such vast phenomena; indeed, perhaps it casts out of its innards much more matter still than it has so far been granted us to know or to observe. Certainly countless faculae, shadows and spots are, without any doubt, generated and corrupted again which never come into our view, however watchful we are in directing and fixing our eyes on them at all times: both because the sky is quite often cloudy, and because of the rarity of the matter. Above all, how many spots are generated in the hidden hemisphere of the Sun, and are destroyed there again, before they reach our visible horizon and rise for us? — to say nothing of the case if all the fainter and smaller spots, faculae and secondary shadows, which wholly escape the sight, were to be taken into account here. So it is beyond doubt that the Sun is indeed still expiring a great deal of matter day by day, while we are quite unaware and unsuspecting.

[Margin: Immensâ fumidarum evaporationum copiâ, ad componendas maculas opus eſt.] *An immense abundance of smoky evaporations is needed to compose the spots.*

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559 the table heads the page, above the prose, in one ruled frame, with no title of its own; it continues the series of the preceding page's table. The first column carries the row labels and no heading. The columns from the true diameter onward stand under the heading "At the mean distance of the Sun from the Earth of 5160 semidiameters of the Earth" [Ad diſtantiam Solis à Terrâ Mediam 5160 Semid. Terræ.]; the box above the first three columns is empty. The last four columns stand under the further heading "Apparent diameters of the spots, if their distance from the Earth is set at" [Diametri Apparentes Macular. ſi ſtatuatur / ipſarum diſtantia à Terrâ.], in which a short oblique stroke of unclear function stands before "ipſarum"; each column is then headed by its distance, printed "60 S.T.", "72 S.T.", "96 S.T." and "110 S.T.". The Sun is printed in the second and third headings by its sign. The units, printed below the headings, are given in the second row in italics as printed; each value printed as two or three figures is given here as one. The ratio is printed as 1, a long rule and the denominator. Rules divide the rows into four groups of three. No label row stands below the last row of figures.

[Margin: Sol adhuc longè plùs materiarum & effluviorum exſpirat, quàm unquam nobis obſervare datur.] *The Sun expires far more matter and effluvia still than it is ever granted us to observe.*

For the rest, what, I ask, do you think: how great a quantity of effluvia does the Sun hurl out every year and every month? But you will perhaps be amazed that I am not afraid to pronounce something certain on this matter — and indeed on such utterly abstruse things, so very remote from our senses; without doubt you are convinced that there is need of a greater en-

[Margin: Quantum evaporationum, & halituum Sol ſingulis annis ejiciat.] *How much in evaporations and vapours the Sun casts out each year.*

deavour than was Archimedes', when he inquired how great the number of grains of sand would be with which the whole world, or one ten times larger, would be filled. But although that very task was somewhat laborious for Archimedes, it was nevertheless not in vain; so too this, which we have now set ourselves to investigate, will, I hope, with the divine Power favouring it, turn out happily, and indeed more quickly.

[Margin: Hæc quæſtio ferè ſimilis illi Archimedeæ de numero arenæ videtur.] *This question seems almost similar to that Archimedean one on the number of the sand.*

First, then, observations plainly show that sometimes, even in the course of a single year, a hundred, indeed two hundred spots have appeared in the visible hemisphere of the Sun, apart from all those which, because of their thinness, eluded the keenness of the eyes, or lay hidden in the other, concealed hemisphere of the Sun. Yet they were not all found to be of entirely equal size. Some, the very smallest, took up scarcely 1/300 or 1/200 part of the Sun's diameter; others again, somewhat larger, subtended 1/30, 1/25, 1/20, indeed 1/18 part of the Sun's disc — to say nothing of all those faculae and shadows that arose together with the spots themselves, which certainly possessed twice as much matter as all the spots visible during that whole year. But be that as it may, let us freely pass over the faculae and shadows, lest we seem to do violence to the attempt; and this time let us set before everyone's eyes only those spots which we ourselves observed in the Sun in the years 1643 and 1644.

[Margin: Quot & quales maculæ uno anno aliquando in diſco Solis animadverſæ fuerint.] *How many spots, and of what kind, have sometimes been observed in the Sun's disc in one year.*

When all of these, as presented in the *Selenographia*, are well considered, you will find — especially if you take a middle course, somewhat reducing the larger ones of 1/20 and 1/18 of the Sun's diameter and slightly increasing the smaller ones — that one can without injustice, on this condition, count forty spots and assume them to be visible in a single year, all of them taking up at least 1/50 part of the Sun's diameter.

[Margin: Quot maculas Autor uno anno deprehenderit.] *How many spots the author detected in one year.*

If each of these is subjected to calculation, and the area of the great circle of those spots is properly computed — as can very easily be done, since the area of a single spot of 1/50 part has already been shown in the preceding table — that is, by multiplying that same area of 525,500 German miles by 40 spots, the product will be the whole matter of these 40 spots, namely 21,020,000 in cubic miles. This number, divided by the area of the circle or disc of the Moon, gives a quotient of about 137. And so many phenomena, I say, can be produced from the solar vapours in the space of one year, wholly equal to the lunar disc as regards diameter; while to the terrestrial [disc], no fewer than 9 1/19; indeed 39 1/5 comets, entirely similar, namely as regards the area of the great circle, to the one existing in the year 1652, would be created from the same matter, so that the thickness came to a German mile; and moreover they would have the same thickness as the larger sunspots — which spots, believe me, are for the most part thicker than the comets themselves, as it would not be difficult to prove more fully, if paper were not to be spared.

[Margin: Quot phænomena Lunæ Terræq; quoad diſcum æqualia Sol unico anno progignere queat.] *How many phenomena equal to the Moon and the Earth as regards the disc the Sun can produce in a single year.*

From this it is now clearly proved how great a mass of matter and of exhalations can be exhaled from the body of the Sun alone, so that in the course of a single year it is possible, as we were just saying, for very many comets to be generated. But truly, granting that only 20 spots of the above-mentioned size of 1/50 part of the Sun's diameter were born in one year (even if in the years 1643 and 1644 many more spots existed, while all the remaining fainter ones, the faculae and the shadows, which by their bulk surpassed even 100 spots, are left wholly out of account), nevertheless 68 comets to the lunar disc, and 4 1/2 to the terrestrial; indeed, to the comet of the year 1652, 19 6/10 entirely equ-

[Margin: Quot igitur Cometæ ex Solari materiâ uno anno coagulari poſſint ?] *How many comets, then, can be congealed from solar matter in one year?*

al, can be congealed from so great a quantity of the matter of the spots — every single year, that is. I put this forward, however, so that you may understand that I have in no way done violence to this argument of ours, and at the same time so that it may become the more clearly known that even from the Sun itself alone much more matter flows out and boils up than suffices for comets — let alone that remarkable comets can sometimes come forth from all the planets together, of which 12 have now become known.

Indeed, if we examine the matter still more carefully, it will be shown, and not obscurely, that in certain years a far greater abundance of expirations still has flowed out of the Sun than we have in fact assumed. For in the year 1625, on the testimony of Scheiner in the *Rosa Ursina*, far more frequent spots were observed in the Sun than in the years 1643 and 1644 — some hundreds, that is, if account is taken of them all. Of the principal ones alone, which the author named above marked with letters, there were 153 in number, although he sometimes took four and five for a single one. When these are properly

considered as a whole, they can rightly be taken for 100 spots taking up 1/50 part of the Sun's diameter. And with the calculation set up in this way, it is clearly established that from that same matter there could have been formed 342 comets not inferior to the Moon's disc, and 23 to the Earth's, while 98 were not inferior to the comet of our year 1652 (as regards size, that is) — even leaving out of account all those shadows, clouds and faculae that appeared together in abundance in the same year.

[Margin: Quot maculæ anno 1625 in Sole conſpectæ fuerunt.] *How many spots were seen in the Sun in the year 1625.*

[Margin: Quot Cometæ ex iſtis maculis iſto anno potuisſent generari.] *How many comets could have been generated from those spots in that year.*

Meanwhile, however, I would have you know that the Sun does not exhale equally many spots every year, but more at one time than at another; just as it also happens to our Earth in exhaling vapours that at different times of the year it fosters more frequent clouds, rains, snows and other meteors. But when such a barrenness occurs in those denser effluxions from which the spots are consolidated, it may be that then — so far as one may divine by conjecture — far more of the thinner exhalations are cast out of the Sun to form comets. Yet these are not always so packed together and gathered, or joined with the effluvia of other planets, that they plainly meet the eyes of all.

[Margin: Non ſingulis annis æq́; multùm materiæ, Sol ex corpore ſuo evomit.] *The Sun does not vomit forth equally much matter from its body every year.*

In sum, we think we have shown more than sufficiently how many vapours and exhalations the Sun alone can vomit forth. For sometimes, when a remarkable fertility befalls it (since at fixed times it too undergoes its own stimulations and exacerbations, as happened in the year 1625), the Sun is able to cast out and exhale in one year so great an abundance of matter and of expirations that it can produce 8 comets every month — that is, two every week — wholly equal, as regards the disc, to that [comet] of the year 1652; indeed, nearly one equal to the Moon every day, as the calculation shows. Therefore, since the single body of the Sun produces so many exhalations and evaporations in the space of one year, how many, I ask, will all the planets together supply over an interval of, at times, many years? Since this is entirely so, I cannot wonder enough, again and again, how it ever happens that comets are not more frequent, since sufficient matter wanders here and there through the whole aether. But perhaps very many are unobservable because of the rarity of their matter, the thinness of their body and their excessive distance, so that they vanish too soon, before they come into view.

[Margin: Immenſam itaq́; evaporationum copiam Solem exhalare, etiam nonnunquam ad innumeros Cometas producendos, apertè demonſtratur.] *It is thus plainly shown that the Sun exhales an immense abundance of evaporations, sometimes even for producing innumerable comets.*

[Margin: Autor iterum iterumq́; demiratur non plures Cometas ſub adſpectum nobis cadere.] *The author wonders again and again that more comets do not come into our view.*

From this, further, one can recognize how immense an abundance of matter all the fixed stars, each and every one — so innumerable, and bodies so very vast, far exceeding the planets in bulk — are able to cast out and exhale. Likewise, it is no wonder that in the course of time one or another new star meeting our eyes can be generated from it; but it is most probable that a great many smaller new ones, which wholly escape the keenness of the eyes, are brought forth rather often in the system of the fixed stars.

[Margin: Non abſonum eſt perplures novas Stellas tractu temporis exoriri poſſe.] *It is not absurd that very many new stars can arise in the course of time.*

Finally, from this rather lengthy discussion of ours above, anyone now [?] also understands without difficulty that, although the ethereal bodies constantly expire and emit effluvia and perpetually belch forth much matter, nevertheless nothing whatever is lost to those bodies, nor do they suffer any decrease or detriment from it. For just as the Sun, as has been most evidently demonstrated, continually casts out effluxions and evaporations — and indeed in such abundance that so very many bodies, far the vastest, can be congealed from them in a short space of time without any detriment to its own body — so it is arranged in the same way with the remaining bodies of the planets, so that they are by no means changed on that account, much less diminished. For even if at one time they exhale exhalations, at another time in turn they recall them and draw them back, so that nothing but a certain circulation of nature, or as it were a flux and reflux of evaporations and expirations, takes place in those bodies. And so whatever is lost to them at one time is added to them again at another, so that they always persist firmly in the same course and in an unvaried state as regards the whole, just as they were created in the beginning.

[Margin: Clarè oſtenditur, licet corpora ætherea immane quantum exhalationum ejaculentur,nihil tamen prorsùs illis decedere.] *It is clearly shown that, although the ethereal bodies hurl out an enormous quantity of exhalations, nothing at all is lost to them.*

Empty, therefore, is the fear that the celestial bodies, because of the alteration of their parts, will at last dissolve and perish; and vain too is the superstition that the aether is subject to no generations and corruptions at all. For, as has been urged more than once, the celestial generations, mutations, alterations and corruptions are far more remarkable and greater than the sublunary ones. Admittedly, if each and every exhalation and evaporation that our Earth daily thrusts out all around into the atmosphere and expires, and from which clouds and other meteors are produced in the sublunary air, could be counted, the abundance of effluvia would likewise be huge, believe me — perhaps even greater than you would ever have imagined. But be that as it may, in comparison with the celestial expirations they come into no consideration at all.

[Margin: Metuunt quidem Antagoniſtæ, ne corpora Cœleſtia diffluant; ſed fruſtrà.] *The opponents do fear that the celestial bodies may dissolve; but in vain.*

Lastly, since so very many exhalations wander through the whole ethereal air, it is rightly asked whether they meet our eyes and produce for us some parallax, or refraction. By no means, certainly. For since those most abundant solar effluxions, clinging almost perpetually about the Sun, are in no way perceived by the naked eye, and, so far as one can judge, do not cloud the Sun itself in any way, how, I ask, will you notice them in the remaining planets, bodies so much more remote and smaller? Their effluxions are for the most part so very thin that they wholly escape all sight; and besides, they are dispersed so sparsely through the whole aether as far as the fixed stars that they can by no means be grasped by the senses. Indeed, although a tract of exhalations, huge in itself, may cling here and there, the matter is nevertheless of no account at all, if the most ample

[Margin: Utrumne evaporationes æthereæ refractionem aliquam inducant ?] *Whether the ethereal evaporations induce any refraction.*

field in which they dwell. For there they rarely present a magnitude of one or two seconds; and how, I ask you to judge for yourself, could so very small a thing ever be noticed in that most vast system of the world, whose diameter, computed in semidiameters of the Earth, contains 150,000,000; its circumference 471,000,000; its concave surface 70,800,000,000,000,000; and its solid content 1,767,000,000,000,000,000,000,000 semidiameters of the Earth? Will it not vanish altogether and withdraw itself entirely from our senses? So it would happen with terrestrial clouds, if they were viewed from the planets, let alone from the fixed stars. But enough of these matters.

[Margin: Magnitudo, & vaſtitas totius Mundi Syſtematis.] *The magnitude and vastness of the whole system of the world.*

Now the order of the work seems to require that we turn to the remaining questions. But it will serve our purpose better if, before we come to them, we first treat somewhat more fully and specifically of the generation of comets — namely of their first rising, increase, decrease and destruction — and then illustrate all of it with certain figures, as accurately as can be done. For discussing this matter, the generation and corruption of the solar spots will certainly contribute not a little. For surely nothing in the whole machine of the world is so joined to comets in its affections and properties, and agrees with them so exactly in most respects, as the said solar spots. We have indeed already stated this in part at the beginning of this book; but since it was not yet developed there as far as would suffice, nor could it be done at such length, we shall therefore discharge it the more amply now. Before we may come down to that, however, it will be worthwhile to set before everyone's eyes in advance the properties and the very nature of the solar spots — namely how they are generated and dispersed again, and whatever is most worth noting in the same matter (since comets enjoy almost entirely similar properties). This will not only do much toward a fuller and easier understanding of this subject; it will also allow us

hereafter to argue correctly that what happens in the Sun and its evaporations and effluxions is no less likely to be able to happen in the remaining bodies too, and in comets as well, which exist in the same medium, or aether. Moreover, since we see that comets agree with the spots in most respects as regards their rising and destruction, [it will allow us to argue] that it is not absurd [that they] are likewise akin to the same spots in those remaining respects that are not so plainly grasped. Nor do such inferences displease Aristotle himself, since he holds that one must judge of remote things according to the way near things are, and that similar effects point to similar causes. Since, therefore, the solar spots evidently show the manner of the generation of the ethereal bodies, it will certainly also be easy for anyone to perceive how the generation of comets comes about, and then how matters stand in this business with the remaining phenomena.

[Margin: Maculæ Solares cum Cometis, ratione proprietatum, & affectionum, valdè conveniunt.] *The solar spots agree closely with comets in respect of their properties and affections.*

[Margin: Maculæ multùm luminis Cometis conferunt, inprimis ratione generationis.] *The spots shed much light on comets, especially in respect of their generation.*

But to approach the matter itself, it will be necessary to recall to memory once more that the spots themselves are ethereal bodies, and very near the Sun, as has been abundantly shown in the *Rosa Ursina* and in the *Selenographia*. If these do not yet satisfy someone, let him make observations himself: he will find by experience that the matter is entirely so. But what properties the spots enjoy besides, both in

[Margin: SuccinctaMacularum Solarium deſcriptio.] *A concise description of the solar spots.*

their first rising and in their whole duration and destruction, must now be told somewhat more fully. Although this is a very lengthy business, nevertheless, so as not to be too burdensome to the kind reader, I shall aim at brevity and gather everything that seems to bear on it into certain definite assertions and aphorisms. Just as these, certainly, rest on undoubted observations of many years, Scheiner's as well as our own, so they can also be demonstrated to anyone at any time by daily observations.

1. The solar spots have a twofold rising and setting, physical and astronomical. The physical is when they really are born and perish; the astronomical, when they seem to enter and leave the visible hemisphere.

[Margin: Ortus Phyſicus, & Aſtronomicus Macularum Solarium.] *The physical and the astronomical rising of the solar spots.*

2. They are generated at every time of the year, not far from the Sun, out of a most thin matter, at first entirely imperceptible to us, belched forth and evaporated from the Sun itself — or out of solar vapours and exhalations. Then they grow, and either remain for some time on the disc of the Sun, or are moved by reason of the Sun's rotation. Afterwards they decrease

again little by little, are at last dissolved, and pass into the most thin ethereal air.

[Margin: Quando generentur; an creſcant, & decreſcant ?] *When they are generated; whether they grow and decrease.*

3. They have a threefold time — of increase, of standing, and of decrease — and this is to be taken both optically and physically.
4. Physical increase and decrease do not belong to any one particular region of the Sun, as optical dilatation and contraction do; rather, they take place in any part of the Sun whatever, and indeed successively, yet gradually and unequally. Hence it happens that a spot which grows slowly and lasts long sometimes fails quickly; and in turn, one that springs up quickly lasts long, and at last is extinguished slowly and gradually. Sometimes one is enlarged quickly, grows faster than one would expect, and condenses; it decreases in the same way and is resolved into shadows. Another, on the contrary, [does so] very slowly.

[Margin: De augmento & decremento Macularum Phyſico.] *On the physical increase and decrease of the spots.*

5. The spots are begotten and increased by the concourse of like matter to like, by condensation, by adgeneration, by substantial generation, and by the aggregation of several very small spots; and in the contrary way, in turn, they are diminished, resolved, and perish.

[Margin: Quomodo procreentur.] *How they are produced.*

6. The spots are not spherical bodies but extended, flat ones, though of varying thickness, presenting sometimes regular figures, mostly round, and sometimes irregular figures of any kind. For near the Sun's horizon the spots grow slender, while near its centre they appear broader and more extended; but this could not happen if they were spherical bodies. For every spherical body always appears with the same round face, whether you view it under direct or under oblique rays, as is clear from optics.

[Margin: An corpora omninò ſint ſphærica ?] *Whether they are spherical bodies at all.*

7. The spots are extremely diverse and unequal, as much in figure, size, thickness and depth as in colour, darkness, density and rarity.
8. Just as not all of them are uniform throughout in darkness and density, nor in colour either, but the greatest part of the spots consists of diverse parts, rarer and more opaque, so too they sometimes possess nuclei of the most diverse thickness, density and colour, as can usually be seen in those larger spots.

[Margin: Sunt inæquales figurâ, denſitate & colore.] *They are unequal in figure, density and colour.*

9. The nuclei, like the spots themselves that are uniform and simple — that is, without nuclei — and consist of [?] uniform and equally dense matter, grow and decrease. Gradually they become large [?] small, and in the same way from large they become small. Moreover, those that do not

last [?] long usually grow and diminish very quickly; but those that grow large [?] gradually also persist longer.

[Margin: Nuclei Macularum, an augeantur & deminuantur ?] *The nuclei of the spots: whether they are increased and diminished.*

10. The nuclei, just like the spots themselves, quite often arise out of shadows and faculae, and out of the smallest [?] ones; and out of many they coalesce little by little — indeed fairly quickly — so [?] that not rarely one is born out of many separate nuclei, and in turn out of one there are sometimes born two [?], three or more.
11. The nuclei do not always stand precisely in the middle of the spot; rather, they now and then decline to the sides [?], and quite often they draw some thinner mass after them.

[Margin: Nuclei, num centrum ſemper in maculis obtineant ?] *The nuclei: whether they always hold the centre in the spots.*

12. The nuclei, like the spots, grow and darken [?] from the inflow of matter and from condensation; conversely, from the outflow of matter and from rarefaction they become paler and whiten [?].
13. Every spot endowed with a nucleus, whether one or several, is clothed [?] round with some other body, less dark and rarer, so that it is surrounded by a peculiar atmosphere [?], as it were, sometimes rarer, sometimes denser. This shines out plainly from that [?] halo and rainbow by which they are sometimes girded.

[Margin: Nuclei habent ſuas atmoſphæras.] *The nuclei have their own atmospheres.*

14. No nucleus is observed to be born physically at the same time as its spot; [?] no spot sets whose nucleus does not first fail gradually, so that the more solid [?] and denser parts suffer dissolution sooner than the thinner ones.

[Margin: Tardiùs Nucleus naſcitur, & rursùs citiùs evaneſcit, quàm reliqua macularum materia.] *The nucleus is born later, and in turn vanishes sooner, than the rest of the matter of the spots.*

15. Neither the spots nor the nuclei are generated or corrupted always in the same [?] place. In longitude they are generated over the whole disc of the Sun without distinction [?]; in latitude, however, they have a peculiar zodiac and fixed limits [?], within which they usually carry on these changes, alterations and vicissitudes. But around the polar parts of the Sun nothing but very thin secondary spots is seen [?]. The reason is this: the motion of the Sun and of its atmosphere around the ecliptic and the intermediate parts — namely the torrid zone — is more vigorous, and consequently its power is more lively.

[Margin: Maculæ habent peculiaremZodiacum.] *The spots have a peculiar zodiac.*

16. The spots and nuclei, and the faculae as well, are some longer-lasting than others by reason of their underlying matter [?]. Some first rise near

the eastern limb of the Sun and vanish in the middle [?] of the disc after a few days; some are born in the middle of the disc and perish near [?] the Sun's western horizon; some, more solid and more opaque, travel across the whole [?] disc of the Sun, sometimes growing, compacting and condensing [?] themselves, sometimes decreasing, thinning and rarefying themselves. Some remain in their state for a long time [?], so that they not only pass once across the visible hemisphere of the Sun, but [?] also across the whole hidden one, and come forth [?] again a second time above the eastern horizon and persist there for some time. But they very rarely return a third time — indeed almost [?] never (as far as I have observed). For that matter is at last scattered and resolved into the thinnest ethereal air. Hence some spots are seen without an astronomical rising, and some without an astronomical rising and setting; others too are seen in the visible hemisphere [?] without a physical rising and setting. And so none endures for ever, but at last vanishes, and others arise in their own time when new matter is supplied.

[Margin: Aliæ aliis ſunt diuturniores,& ſolidiores.] *Some are longer-lasting and more solid than others.*

[Margin: Nonnullæ Maculæ quoties redeant.] *How often some spots return.*

17. Two spots often appear equal at the beginning, both in matter and in size and consistency; and yet they perish not at the same time, but at a different time and place.

[Margin: Non omnes ſimul intereunt.] *Not all perish at the same time.*

18. Every spot consists of opaque, dense and blackish matter; the light it possesses, however, it draws from the Sun, and it enjoys no light of its own.

[Margin: Lumen ex Sole hauriunt.] *They draw their light from the Sun.*

19. The spots are larger than they appear. For since they are far smaller than the Sun, the illuminating body, they are therefore illuminated over more than half [their surface], like the Moon.

[Margin: Sunt opinione majores.] *They are larger than one supposes.*

20. No spots revolve about an axis; rather, with an even course, always keeping the same face where they face the Sun and the Earth, they are carried round the centre of the Sun, like terrestrial clouds. For no spot grows slender near the centre.

[Margin: An maculæ circa axem circumgyrentur ?] *Whether the spots turn about an axis.*

21. The spots move across the disc of the Sun regularly, but in different ways at different times of the year: sometimes in a straight line, sometimes in a circular — or rather an elliptical — one. The concavity of this section, and sometimes its convexity, faces the ecliptic, though at a differing inclination. This motion does not belong to the spots as their own; it belongs to the Sun, or rather to the Earth, and depends on the Earth's annual motion, if the matter is weighed accurately. That the spots seem

to advance more slowly on one day or another, however, is to be ascribed to their own natural motion, which as it were resists and opposes the regular rotatory motion of the Sun.

[Margin: Regulari quidem,ſed ſingulis menſibus, diverſo motu, in univerſum moventur.] *On the whole they are moved with a regular motion indeed, but with a different one in each month.*

22. They move continuously, and indeed uniformly with respect to the Sun, but unequally in appearance. Hence in the middle of the disc the daily motion seems swifter and greater, and near the horizons slower and smaller; and the nearer they stand to the horizon, or limb, the tighter, narrower and smaller the space of their journey — that is, their daily space — that they complete, by reason of their more oblique position and aspect.

[Margin: Motus macularum apparens eſt inæqualis.] *The apparent motion of the spots is unequal.*

23. The spots also possess a proper motion of their own, but one perpetually irregular and anomalous. Hence those corpuscles and nuclei of which the whole spot consists move in different ways with respect to one another: they approach and recede, are joined and separated, gathered and dispersed. And from this arise the sudden coalitions of the spots, their abrupt digressions, their disordered deviations, and the perpetual transformations of their figures.

[Margin: Motus illarum proprius pariter eſt anomalus.] *Their proper motion is likewise anomalous.*

24. Although the spots are bodies of wonderful size — so that some sometimes exceed the diameter and disc of the Moon, indeed of the Earth — they nevertheless do not exhaust the Sun, nor does the Sun suffer any decrease from them. For when the matter is dissolved and attenuated, the Sun in turn draws it back and receives it, as the Earth does its vapours and exhalations.

[Margin: Quantæ ſint magnitudinis.] *How large they are.*

25. The spots of the Sun are not equidistant from the surface of the Sun; some are more remote than others. Yet none is so far removed from the Sun that it could suffer any sensible parallax.

[Margin: Quamvis non æquali à Sole removeantur interſtitio;nullam tamen parall. patiuntur.] *Although they are removed from the Sun by an unequal interval, they nevertheless suffer no parallax.*

26. The Sun does not always nourish spots on its disc; sometimes it is entirely free of every primary spot and of the more notable shadows and faculae, so that sometimes for a space of several months hardly anything worth noting is found on the disc of the Sun.

[Margin: Nonnunquam Sol ab omni maculâ prorsùs liber eſt.] *Sometimes the Sun is entirely free of every spot.*

Diagram. Engraved folding plate, "Fig. D.", of which this page shows the left part; the rest of the same plate is the next page. Eight rows of drawings of spots run across the plate, each row headed at the right by a two-line caption that begins with its Roman number, I to VIII: "Facies Macularum …" *Appearance of the spots …*, then "Anno 1625, à Die …" *in the year 1625, from the day …*. Under each caption the drawings stand in a line, each with an engraved number above it and one or more small letters beside it. The spots are drawn as hatched dark cores, many of them inside dotted or lightly hatched outlines, some as scattered clusters of small dots. Near the right edge of this part a vertical fold crosses the whole plate; beyond it only a narrow strip of the next panel shows. Every caption runs into the fold and on beyond the edge of this part, so the end of each caption is not read here. "Fig. D." stands at lower left. All labels on this part of the plate are listed below; none is supplied from the text.

- Row I. Caption: "I Facies Macularum" *I. Appearance of the spots*, followed by a word beginning with S, broken by the fold [?]; "Anno 1625, à Die" *in the year 1625, from the day* [?] February [?]. Drawings: *10*; *11*, with *b*; *12*, with *c* and *b*; *14*, with *c* and *b*; *15*, with *c*.
- Row II. Caption: "II Facies" *II. Appearance of the spots* [?]; "Anno 1625," *in the year 1625*, [?] *day* [?]. Drawings: *23*, *24*, *25*, *26*, *27*, each with *c*; *28* (beyond the fold).
- Row III. Caption: "III Facies Macularum" *III. Appearance of the spots* [?]; "Anno 1625, à" *in the year 1625, from the d[ay]* [?] *11* [?]. Drawings: *11*, *12*, *13*, *14*, *15*, each with *a*; *16* (beyond the fold).
- Row IV. Caption: "IV Facies Macularum" *IV. Appearance of the spots*, followed by a word beginning with S, broken by the fold [?]; "Anno 1625, à Die" *in the year 1625, from the day* [?] June [?]. Drawings: *8*, *9*, *10*, *11*, *12*, *13*, each with *k*.
- Row V. Caption: "V Facies Macularum" *V. Appearance of the spots* [?]; "Anno 1625, à Die 1" *in the year 1625, from the day 1* [?] July [?]. Drawings: *12*, *13*, *14*, *15*, *16*, each with a small oval that may be the letter *o* or a cipher [?].
- Row VI. Caption: "VI Facies Macularum" *VI. Appearance of the spots* [?]; "Anno 1625, à 7" *in the year 1625, from the 7th* [?]. Drawings: *7*, *8*, *9*, *10*, *11*, each with *a*.
- Row VII. Caption: "VII Facies Macularum" *VII. Appearance of the spots* [?]; "Anno 1625, à 18" *in the year 1625, from the 18th* [of Au]gust [?]. Drawings: *18*, *19*, *20*, each with *a*; *21*, with a small mark that may be *a* or *o* [?]; then *a*; *22*; a number beginning with 2, cut by the fold [?]; *a*.
- Row VIII. Caption: "VIII Facies Macularum" *VIII. Appearance of the spots* [?]; *in the year 162*[?], *from the day* [?]. Drawings: *31*, *1*, *2*, *3*, *4*, each with *c*; *5*, with *c* (beyond the fold).
- Lower left: "Fig. D."

Fig. D, right part. This page shows the right part of the same folding plate Fig. D described on the previous page: a narrow strip of the left part, the fold,

and then the rest of the eight rows, each caption running on from the left part. All labels on this part of the plate are listed below; none is supplied from the text.

- Row I. Caption, continued: "rium obſervata Romæ," *solar [?], observed at Rome*; "10Febr. ad 21 ejusdem." *10 February, to the 21st of the same [month]*. Drawings: *5* (the end of 15, at the fold); a drawing with *b*, its number not on this part; *17*, with *c* and *b*; *19*, with *c* and *b*; *20*, with *c* and *b*; *21*.
- Row II. Caption, continued: "Solarium obſervata Romæ," *solar, observed at Rome*; "Die 23 Martii, ad 3 Apr." *…25,* [?] *the day 23 March, to 3 April*. Drawings: *28*, *29*, *30*, *31*, *1*, *2*, *3*, each with *c*.
- Row III. Caption, continued: "larium obſervata Romæ," *solar [?], observed at Rome*; "1 Maji, ad 22 ejusdem." *day* [?] *1 May, to the 22nd of the same [month]*. Drawings: *16*, *17*, *18*, *19*, *20*, *22*, each with *a*.
- Row IV. Caption, continued: "rium obſervata Romæ," *solar [?], observed at Rome*; "unii, ad 18 ejusdem." *8 June [?], to the 18th of the same [month]*. Drawings: a *k* before the fold (beside the drawing numbered 13 on the left part); *14*, *15*, *16*, *17*, *18*, each with *k*.
- Row V. Caption, continued: "rium obſervata Romæ," *solar [?], observed at Rome*; "ulii, ad 22 ejusdem." *12 July [?], to the 22nd of the same [month]*. Drawings: *17*, *18*, *19*, *20*, *22*, each with a small oval that may be the letter *o* or a cipher [?].
- Row VI. Caption, continued: "arium obſervata Romæ," *solar [?], observed at Rome*; "sti, ad 17 ejusdem." *August [?], to the 17th of the same [month]*. Drawings: *12*, *13*, *14*, *15*, *16*, *17*, each with *a*.
- Row VII. Caption, continued: "rium obſervata Romæ," *solar [?], observed at Rome*; "usti, ad 28 ejusdem." *August [?], to the 28th of the same [month]*. Drawings: *23* (before the fold); *24*, *25*, *26*, *27*, *28*, each with *a*.
- Row VIII. Caption, continued: "larium obſervata Romæ," *solar [?], observed at Rome*; "Octob. ad 10 Novemb." *[?] October, to 10 November*. Drawings: *5*, *6*, *7*, *8*, *9*, *10*, each with *c*.
- Lower right, inside the plate mark: "Autor ſculpsit." *Engraved by the author.*

And these are the genuine, and indeed the most conspicuous, properties of the solar spots; and it is plainly in this way that they arise, subsist for some time in the aether, and set in their own time, with no spot at all contradicting it. But so that the matter may be made still clearer, and the most eager investigator of the secrets of nature may be satisfied all the more, and his thirst in some measure quenched — especially since it is also most expedient for our present purpose, where we are to treat of the genuine physical rising and setting of comets and of other matters bearing on this — we have decided to display, in certain figurations, various periods of the spots, acquired from the sky itself at different times with the utmost diligence and delineated, as much by Scheiner as by ourselves. By means of these spots, everything that has been asserted in the preceding aphorisms can be clearly demonstrated.

[Margin: Figurationibus, & exemplis quibusdam res elucidatur, ac asſertiones omnes ſuperiores ſtabiliuntur.] *The matter is elucidated by figurations and certain examples, and all the assertions above are established.*

Above all, however, in these delineations of the spots I shall work to this end: that I depict exactly such [spots] in which their first generation, accretion, augmentation, coalition, condensation, and the packing together of their nuclei appear exquisitely and clearly; likewise, by what way their dissolution, rarefaction, segregation and diminution come about in turn; and then by what means they are at last entirely extinguished and vanish — in accordance with our assertions 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17 and 23. For to comprehend and elucidate each and every case in so few figures is a thing altogether impossible. Whatever is not contained in these diagrams, however, can be deduced with the greatest ease from the very sources of the observations. For nothing at all has been asserted by us that is not supported by sure experience of things and derived from the most approved observations.

[Margin: In delineationibus inprimis progreſſio generationis,& diſſolutionis attenditur.] *In the delineations attention is paid above all to the progression of generation and of dissolution.*

Next, so that we may sketch the progression of the generation and dissolution of the spots the more accurately, we have not wished always to keep exactly the same size for them as was depicted in the originals, but have taken it somewhat larger, while preserving, as far as we could, the due proportion. Nor have we resolved to observe so strictly and constantly their daily motion, or how much space they actually completed in the course of their journey; rather, we shall give the spots drawn as if they had travelled equal paths on each single day, that motion — unequal [and] optical [?] by reason of the rotation of the Sun — being entirely set aside. As for that other motion, however, the spots' own proper and natural anomalous one, care will be taken that it is duly expressed, as far as can be done. Moreover, I do not wish you to be unaware that we have also deliberately neglected the annual inclination of the trajectory, convex at certain times and concave at others with respect to us; and that in all the delineations we have represented the path of the spots by straight lines only. For on this occasion we are concerned not with the line of advance, nor with the motions of comets (which is reserved for elsewhere), but with how the varieties and vicissitudes of generation and corruption may be demonstrated correctly and clearly; and this will be accomplished best of all only by straight lines. If anyone, however, burns with the desire to understand that motion, let him consult the *Rosa Ursina*, the *Selenographia*, and above all Book IX of this our *Cometographia*; I do not doubt that he will be thoroughly instructed.

[Margin: Quid porrò in Iconiſmis notandum ſit.] *What is further to be noted in the figures.*

[Margin: De generatione & corruptione Macularum Solarium.] *On the generation and corruption of the solar spots.*

From these sixteen periods of the solar spots, therefore, drawn accurately for each single day of their appearance, partly by Scheiner and partly by ourselves, it is per- spicuous that all the spots are first coagulated from the most tenuous and rarest solar matter, and at last resolved into the same once again. This appears clearly above all from those that had their beginnings on the visible hemisphere of the Sun and ceased to exist there again: namely, from the appearance of the solar spots III, IV, V, VII, VIII, XIII, XIV and XVI. The matter, that is, more dilute at first, gradually coalesces; then it is brought into a denser [state]; afterwards very small nuclei are created, which at length grow successively into a great mass, and into very dense and very vast bodies. Now several are produced from a single one, now one very compact and more solid from several; and they vary from day to day, indeed not rarely from hour to hour, now joining together and growing, now separating and decreasing, and they undergo truly wonderful and astonishing alterations and changes — just as has been set out in the aphorisms above, and as the observations themselves also declare.

[Margin: Breviſſimo temporis ſpatio, circa maculas admirandæ exoriuntur mutationes, & alterationes.] *In a very short space of time wonderful changes and alterations arise in the spots.*

But what form each spot continuously put on day by day, whether in growing or in decreasing, there is no need to recount here at greater length, since any period of the spots whatever shows it plainly enough, provided it is looked at not with a fleeting eye but with a fixed one. You will no doubt be amazed that within so short a time — the space of a few days, indeed of hours — they are subjected to such wonderful and dreadful changes and vicissitudes. How, moreover, can it ever happen that from such extremely dilute exhalations and effluvia spots and nuclei can be generated as various and dense as they are of wonderful size, as the delineations of the spots II, III, V, VI, IX, XII and XV especially show? But whatever the case may be, all the observations demonstrate that it truly is so. Therefore, if anyone does not yet grasp the individual points, nor believes them, he will be able, if he pleases, to test the same things himself, and so every doubt will be removed.

In an entirely similar way, as you have perceived and see clearly from the very figures of the spots, it is also with comets and with their generation and corruption. For they likewise have a slender beginning from the most subtle matter of the planets, which is expired and ejected from those same bodies, first into the surrounding atmosphere; and then also, according to the suitability of the matter, it is thrust out by that route (by what route, you will learn in Book Nine) into that great sea of the aether. There, in time, it is gradually coagulated [?], grows, is condensed, is joined with other vapours of other planets arriving and meeting it from here and there, and is packed together by them; at length that cometic body is reduced into a very dense mass, and at times into very opaque nuclei. Finally, according to the constitution and abundance of the effluvia, they are preserved in vigour for some time. At last, however, the

comet begins to be dissolved and its matter to be attenuated — not so uniformly, nor in the same way at every time, but now in this way, now in another: now they are reduced into several larger nuclei, now into many smaller ones; and so at last they pass away once more into the most tenuous matter, by no means perceptible to us.

[Margin: QuomodoCometæ naſcantur, & creſcãt; decreſcant, ac intereant.] *How comets are born and grow, decrease and perish.*

Here, however, it must be noted that comets, as happens with the spots, do not always display the same figure or appearance while they grow and decrease, but frequently degenerate, now from a round figure into an elliptical one, now into some other angular and irregular one, according to the proportion of the matter that from time to time increases or decreases. And hence it happens that some co-

[Margin: Cometæ, ut Maculæ figuram ſæpiùs mutant.] *Comets, like the spots, rather often change their figure.*

Diagram. Engraved folding plate, "Fig. E", of which this page shows the left part; the rest of the same plate is the next page. Eight bands of drawings of spots run across the plate, each headed at the right by a two-line caption that begins with its Roman number, IX to XVI: "Facies Macularum …" *Appearance of the spots …*, then "Anno …" *in the year …* with a starting date. Beside each caption the drawings stand in a line, each with an engraved number above it and one or more small letters beside it. The spots are drawn as hatched dark cores, several inside dotted or lightly hatched outlines (bands IX to XI and XIII), some as scattered clusters of small dots, and in band XVI as round cores inside stippled rings. Near the right edge of this part a vertical fold crosses the whole plate; beyond it only a narrow strip of the next panel shows. Every caption runs into the fold, so the end of each caption is not read here. "Fig. E" stands at lower left. All labels on this part of the plate are listed below; none is supplied from the text.

- Band IX. Caption: "IX Facies Macularu" *IX. Appearance of the spots* [?]; "Anno 1625, à 1" *in the year 1625, from 1* [?]. Drawings: *19*, *21*, *22*, *23*, *24*, each with *a*; *5* (beyond the fold).
- Band X. Caption: "X Facies Macularu" *X. Appearance of the spots* [?]; "Anno 1625, à 27" *in the year 1625, from the 27th* [?]. Drawings: *27*, *28*, *29*, *30*, *31*, each with *a*; *1* (beyond the fold).
- Band XI. Caption: "XI Facies Macularum" *XI. Appearance of the spots* [?]; "Anno 1626, à 15" *in the year 1626, from the 15th* [?]. Drawings: *15*, *16*, *17*, *18*, *19*, each with *c*.
- Band XII. Caption: "XII Facies Macularum" *XII. Appearance of the spots* [?]; "Anno 1626, à" *in the year 1626, from* [?]. Drawings: *21*, *22*, *23*, each with *a*, *c* and *b*; *24*, with *a*, *c* and *b*, and then *a* and *c* beside a large spot that follows; *25*, with *b*; beyond the fold, a number beginning with 2 [?], then *a* and *c*.

- Band XIII. Caption: "XIII Facies Macularu" *XIII. Appearance of the spots* [?]; "Anno 1643, à Di" *in the year 1643, from the d[ay]* [?]. Drawings: *14*, *15*, *16*, *17*, each with *e*; a further *e*; *18*, with *e*; beyond the fold, a letter cut by the edge [?].
- Band XIV. Caption: "XIV Facies Macularu" *XIV. Appearance of the spots* [?]; "Anno 1644, à 11" *in the year 1644, from the 11th* [?]. Drawings: *10*, *11*, *12*, *13*, *14*, each with *g*; *15* (beyond the fold).
- Band XV. Caption: "XV Facies Macularum" *XV. Appearance of the spots* [?]; "Anno 1644, à 4" *in the year 1644, from the 4th* [?]. Drawings: *4*, *6*, *7*, *8*, each with *d* and *e*; a mark in the fold [?].
- Band XVI. Caption: "XVI Facies Macularum" *XVI. Appearance of the spots* [?]; "Anno 1644, à Die" *in the year 1644, from the day* [?]. Drawings: *16*, *22*, *23*, *24*, each with *a* and *b*.
- Lower left: "Fig. E"

Fig. E, right part. This page shows the right part of the same folding plate Fig. E described on the previous page: a narrow strip of the left part, the fold, and then the rest of the eight bands, each caption running on from the left part. All labels on this part of the plate are listed below; none is supplied from the text.

- Band IX. Caption, continued: "olarium obſervata Romæ," *solar [?], observed at Rome*; "rilis, ad 30 ejusdem." *19 April [?], to the 30th of the same [month]*. Drawings: *5* (at the fold); *26*, *27*, *28*, *29*, *30*, each with *a*.
- Band X. Caption, continued: "Solarium obſervata Romæ," *solar, observed at Rome*; "sti, ad 6 Septembris." *August [?], to 6 September*. Drawings: *1* (at the fold), *2*, *3*, *4*, *5*, *6*, each with *a*.
- Band XI. Caption, continued: "Solarium obſervata Romæ," *solar, observed at Rome*; "br. ad 25 ejusdem." *[?], to the 25th of the same [month]*. Drawings: *20*, *21*, *22*, *23*, *24*, *25*, each with *c*.
- Band XII. Caption, continued: "larium obſervata Romæ," *solar [?], observed at Rome*; "21 Maji, ad 30 ejusdem." *the d[ay]* [?] *21 May, to the 30th of the same [month]*. Labels, left to right: a letter cut by the edge of the image [?]; *2*; *c*; *26*; *b*; then *a*, *c*, *27*, *b*; *a*, *c*, *28*, *b*; *a*, *c*, *29*, *b*; *a*, *c*, *30*, *b*.
- Band XIII. Caption, continued: "Solarium observata Gedani," *solar, observed at Danzig*; "Augusti, ad 24 ejusdem." *the day 1…* [?] *August, to the 24th of the same [month]*. Drawings: two marks in the fold [?]; *19*, *20*, *21*, *22*, *23*, *24*, each with *e*.
- Band XIV. Caption, continued: "Solarium obſervata Gedani," *solar, observed at Danzig*; "lis, ad 19 ejusdem." *April [?], to the 19th of the same [month]*. Drawings: *15* (at the fold), *17*, *18*, *19*, each with *g*.
- Band XV. Caption, continued: "larium obſervata Gedani," *solar [?], observed at Danzig*; "i, ad 15 ejusdem." *May [?], to the 15th of the same [month]*. Drawings: *10* (before the fold), *11*, *12*, *13*, *14*, *15*, each with *d* and *e*.

- Band XVI. Caption, continued: "rium obſervata Gedani," *solar [?], observed at Danzig*; "Maji, ad 28 ejusdem." *the day 1… [?] May, to the 28th of the same [month].* Labels, left to right: a mark in the fold [?]; *a*, *25*, *b*; *a*, *26*, *b*; *a*, *27*, *b*; *a*, *28*, *b*; *29*, *b*; *30*, *b*.
- Lower right, inside the plate mark: "Autor ſculpsit." *Engraved by the author.*

met, in the course of time abandons its first appearance and form and assumes an entirely different one. Such was the comet that shone forth in the year 348 before the birth of Christ, as Pliny the Elder attests, book II, chapter 25. For he says: *Only once so far has the likeness of a trumpet been changed into a spear, in the hundred and eighth Olympiad, in the three hundred and ninety-eighth year of the City.* So from an equine [comet] the comet became spear-shaped. Without doubt many others of this kind have existed, had they only been carefully recorded by the ancient authors. It is therefore not unreasonable that comets can at times change their appearance and tail, according as matter and nuclei grow onto the head from this side or that, or depart more or less from one side or the other, or are dissolved more quickly or more slowly; but more on these matters elsewhere.

[Margin: Exemplis comprobatur.] *It is confirmed by examples.*

Now, my astrosopher, we shall take pains to set before everyone's eyes, after the likeness of the solar spots, the physical rising and setting of comets likewise, clearly and indeed graphically: namely, how their generation and corruption really takes place, or can take place. To carry out this task the more accurately, the comets of the years 1618 and 1652 will light the way for us, as will a third, which shone recently, in the year 1661, in the month of February; for all the others were not properly observed, nor could they be observed, since at that time the use of telescopes was not yet available. Meanwhile, however, whatever will be asserted about those three, that, I say, we wish to be said of all in general. Let us, then, consider them and sketch them just as they were observed with the help of the optical tube on various successive days, and indeed after the example of the solar spots, which cast towards us not at all the borrowed light of the Sun, but only the shadow of their own body. For since they are entirely opaque bodies, the Sun cannot pierce them through with its rays; rather, they are illuminated only on the side turned towards the Sun and away from us. Comets, on the contrary, almost always show us an illuminated face, the other always remaining invisible, since at the time of conjunction they never come into our view, unless this should happen during some total eclipse of the Sun.

[Margin: Tribus cumprimis exemplis ortus & occaſus phyſicus Cometarum perquàm dilucidè demonſtratur.] *The physical rising and setting of comets is demonstrated very clearly by three examples above all.*

[Margin: Quâ ratione Cometæ iſti delineati fuerunt.] *In what way these comets were delineated.*

And so let us display the comets as if they were seen from the dark side, turned away from the Sun and from us, which can in no way be lit by the Sun;

or, what comes to the same thing, as if the comets were not imbued with the light of the Sun. Then, I say, the whole matter of the comets would appear very dark, like the solar spots; and so all the more solid and more compact parts would be seen as much darker than the more tenuous and more dilute ones. For in this way we shall see clearly that very close affinity which exists between comets and the spots with respect to generation and corruption, and also that nothing more similar can either be given or be imagined. Moreover, [we shall see] that comets as well as spots have an entirely similar character as regards their first origin and their last appearance or dissolution; and also that with those very minute things which cannot yet be noted so accurately in the generation and corruption of comets, it truly stands in the same way as with their more notable increase and decrease.

[Margin: In quibusdam, Cometæ ſimiles ſunt Maculis Solaribus.] *In certain respects comets are similar to the solar spots.*

But to come to the comet of the year 1618 itself, I would have you know that it was observed by Cysat with the help of the telescope not on every single day, but only on some days: namely on 1 December, when, entirely fiery and very bri- ght, it stood out; on the 8th, when it was already decreasing; and on the 17th, 18th, 20th and 24th, when it was already found to be very dark. For these days we have given this comet, correctly drawn, in the attached diagram under the letters E F G H, just as Cysat delineated it in his booklet and carefully described it, but in our own manner: namely, the parts that seemed to him brightest, like little stars, are for us opaque corpuscles and denser nuclei. From the first observation it is clear that the cometic head consisted of a single very dense nucleus, or, if of several, of ones nevertheless closely adhering to one another. This nucleus, however, on 8 December passed into three equally solid ones, and also, without doubt, into other more tenuous ones, as is sketched in figure F; on the 17th and 18th, again, they were reduced into more [nuclei] and into rarer matter; then, on the 20th and 24th, they were successively cut up into far more corpuscles, very minute ones, and dissolved into very dilute evaporations, with a very thin shadow sprinkled here and there, as the delineations clearly show. Hence we rightly conclude that this progress of the nuclei and of the matter, in respect of dissolution and attenuation, detected from 1 December up to the 24th, was continued steadily more and more on the following days and went on unremittingly in that decrease, as is established from Cysat's own observations: namely, that the comet was noticed to be paler day by day and larger as to its diameter. It could not, therefore, have happened otherwise than that the corpuscles and nuclei were gradually separated, and that the matter lying between them also became little by little rarer and more dilute by moving apart and spreading itself out, until the whole mass and heap was entirely dissolved into mere shadows and very subtle evaporations, or a very tenuous aethereal air, like the solar spots.

[Margin: Quâ ratione caput Cometæ 1618 indies creverit,ac immutatum fuerit.] *In what way the head of the comet of 1618 grew day by day and was changed.*

Since, therefore, this comet strictly kept to such a process in decreasing, around its physical setting, we certainly argue rightly (bearing in mind above all that a generation and corruption entirely similar to that of the solar spots, and perpetual, takes place) that the phenomenon also held to exactly the same progress in growing, around its first physical rising: namely, that the cometic body took its origin from the most subtle matter of the planets, which, gradually condensed, was gathered into various growing nuclei, so that at last it turned into a great mass and a remarkable nucleus, according to our fifth assertion: that is, by the concourse of like matter to like, by condensation, by adgeneration, by substantial generation, and by the aggregation of very many most minute corpuscles. This variation of the matter, and the manifold alteration of the corpuscles, we have expressed in certain diagrams [Schematiſmis] B C D, as we judge all those things to have happened.

[Margin: Cometæ ferè eâdem ratione ut creſcunt,ſic & decreſcunt.] *Comets decrease in almost the same way as they grow.*

Now, then, judge for yourself, I beg you: has everything been presented properly, according to the mind of the observer and the tenor of the observations themselves? And are comets also exceedingly similar to the solar spots? Indeed, comets agree with the spots of the Sun not only to the greatest possible degree in generation, increase, diminution and corruption, but also in almost all their remaining properties, as we shall demonstrate more fully below.

[Margin: Summam convenientiam intercedere inter Cometas, & Maculas ultrò agnoſcent omnes.] *All will readily acknowledge that the greatest agreement exists between comets and the spots.*

Now let us approach the comet of the year 1652 and its physical rising and death; but it would be desirable that observing it more often with the telescope had be-

Diagram. Engraved folding plate, "Fig. F.", of which this page shows the left part; the rest of the same plate is the next page. Six bands of round drawings of comet heads run across the plate. Each band is headed by a caption line set towards the right, beginning "Cometa Anno" *Comet in the year*, and a line of dates, one date over each drawing; in the first two bands capital letters also stand over some drawings. The heads are drawn as discs of horizontal hatching: some carry a single dark, cross-hatched nucleus inside a pale ring, others several dark clusters, others only faint streaks and specks. Near the right edge of this part a vertical fold crosses the whole plate; beyond it only a narrow strip of the next panel shows, and every caption runs into the fold, so the end of each caption is not read here. "Fig. F." stands at lower left. All labels on this part of the plate are listed below; none is supplied from the text.

- Band 1. Caption: "Cometa Anno 1618 à" *Comet in the year 1618, à*, followed by letters broken by the fold [?]. Over the drawings, left to right: *B*; *C*; *D*; "1 Decemb." *1 December*, with *E*; *8 December* [?], with *F*; *17 D…b.*, the middle of the word lost in the fold [?]; over the sixth drawing, beyond the fold, a short mark that is not read [?].

- Band 2. Caption: "Cometa Anno 1652" *Comet in the year 1652*, followed by a, a letter broken by the fold, and a word beginning "Au" beyond it [?]. Dates: "15 Decemb." *15 December*; "18 Decemb." *18 December*; "20 Decemb." *20 December*, with *D*; *27*, then letters broken by the fold, *…ece…* [?], with *E* beyond the fold.
- Band 3. Caption: "Cometa Anno 1661" *Comet in the year 1661*, followed by a, a letter broken by the fold, and a word beginning "Au" beyond it [?]. Dates: "3 Februar." *3 February*; "5 Februar." *5 February*; "6 Februar." *6 February*; "7 Februar." *7 February*; "10 Februar." *10 February*; at the fold a figure ending in 3 and the capital F of a month [?].
- Band 4. Caption: "Cometa Anno 1664 et" *Comet in the year 1664 and* [?] *665*, the first figure of the second year lost in the fold. Dates: "14 Decembr." *14 December*; "18 Decemb." *18 December*; "21 Decemb." *21 December*; "28 Decemb." *28 December*; "29 Decemb." *29 December*; *30 Dece…*, cut by the fold [?]; beyond the fold, a date beginning with 3 [?].
- Band 5. Caption: *Comet in the year[s]* [?] *1664 and* [?] *65*, the first figures of the second year lost in the fold. Dates: "9 Januarii." *9 January*; "10 Januar." *10 January*; "17 Januar." *17 January*; "19 Januar." *19 January*; *20 Jan…*, cut by the fold [?].
- Band 6. Caption: "Cometa Anno 1665" *Comet in the year 1665*, followed by a, strokes in the fold, and the letters ctor beyond it [?]. Dates: "6 Aprilis." *6 April*; "7 Aprilis." *7 April*; "8 Aprilis." *8 April*; "10 Aprilis." *10 April*; "11 Aprilis." *11 April*; *13 Ap…*, cut by the fold [?]; beyond the fold, *14* and a stroke not read [?].
- Lower left: "Fig. F."

Fig. F, right part. This page shows the right part of the same folding plate Fig. F described on the previous page: a narrow strip of the left part, the fold, and then the rest of the six bands, each caption running on from the left part. All labels on this part of the plate are listed below; none is supplied from the text.

- Band 1. Caption, continued: letters at the fold [?], then "ato obſervatus." *…ato* [?], *observed*. Labels: *D…*, cut at the fold [?]; a mark in the fold over the cut drawing, not read [?]; "24 Decemb." *24 December*, with *H*; two further drawings with no date or letter.
- Band 2. Caption, continued: "ctore observatus." *observed by the Author* [?], the first letters of the noun at the fold. Labels: *D…b.*, cut at the fold [?], with *E*; "30 Decemb." *30 December*, with *F*; *3 January* or *8 January*, the figure not settled [?], with *G*; "6 Januar." *6 January*, with *H*; *I* standing above "10 Januar." *10 January*.
- Band 3. Caption, continued: "ctore obſervatus." *observed by the Author* [?], the first letters of the noun at the fold. Dates: a figure ending in 3 and the month's capital lost at the fold, then "ebruar." *February* [?]; "17 Februar." *17 February*; "20 Februar." *20 February*; "2 Martii." *2 March*, set higher than the band's other dates.

- Band 4. Caption, continued: a figure ending in 5 and letters at the fold [?], then "ab Auctore obſervatus." *observed by the Author*. Dates: faint letters in the strip before the fold, not read [?]; *December*, its figure lost at the fold [?]; "1 Januar." *1 January*; "3 Januar." *3 January*; "5 Januar." *5 January*; "7 Januarii." *7 January*.
- Band 5. Caption, continued: figures at the fold, of which a 6 is read [?], then "ab Auctore obſervatus." *observed by the Author*. Dates: faint letters in the strip before the fold, not read [?]; "21 Januar." *21 January*; "23 Januar." *23 January*; *30 January* or *80 January*, the first figure not settled [?]; "3 Februarii." *3 February*.
- Band 6. Caption, continued: a, then strokes at the fold [?], then "tore obſervatus." *observed by the Author* [?]. Dates: *Ap…*, cut at the fold [?]; "14 Aprilis." *14 April*; "15 Aprilis." *15 April*; "16 Aprilis." *16 April*; "18 Aprilis." *18 April*; "20 Aprilis." *20 April*.
- Lower right, inside the plate mark: "Autor ſculpsit." *Engraved by the author.*

fallen [us]; as to that, since it in fact happened only once, let us call to our aid the [observations] of others, namely those of Wendelen and also of the Jesuit Fathers, made in Italy and presented in Book IV, p. 328. First, under the letters E and D you have the comet's true face, which it presented to me on 27 December and to Wendelen on the 20th of the same month. Next, under the letters H and I, [you have] the form the comet had on 6 and 10 January, when, like a shadow, a cloud, and very fine corpuscles and dispersed rarer matter, it appeared stripped and bare of all its nuclei entirely, according to the observations we presented in Book VI, p. 327.

[Margin: Quâ rationeCometa an. 1652 incrementa, & decrementa ſua ceperit[?]] *How the comet of the year 1652 took its increases and decreases.*

Since, therefore, from 27 December to 10 January the comet's nuclei, or more solid corpuscles, decreased greatly, and its matter became far rarer and more extended, so that in the end nothing but shadows and very dilute effluvia were observed, it necessarily follows that on the intervening days too the comet decreased, and that the matter of which it was composed was gradually thinned. Moreover, since every decrease, not only in the solar spots but in any natural things whatever, takes place continuously, gradually and successively, it is not wrongly judged that it happened entirely so in this comet too. Its decrease, and the alternation and change of its corpuscles and matters from 20 December up to its death, we have carefully depicted according to our own view in the preceding figure under the letters F and G: namely, how the comet became from day to day truly more dilute and yet larger as to its head, and was at last resolved into the finest matter.

[Margin: Nuclei hujus Cometæ paucis diebus valdè decreverunt.] *The nuclei of this comet decreased greatly within a few days.*

[Margin: Conſequentia infallibilis.] *An infallible consequence.*

I consider that things happened no differently at its first birth and growth: so that its matter, at first very dilute, successively became denser, and was at last also transformed into more solid nuclei, with rarer matter adhering here and there, as is clear from the figure. Yet this difference existed between the two comets: the earlier consisted of larger and more solid nuclei, the later of smaller and thinner ones, not even excepting the day of 20 December itself, when it seemed to have reached its very greatest maturity. Accordingly it also appeared far paler and darker than the earlier comet, exactly like the solar spots that arise from smaller nuclei and rarer matter, which at all times likewise show a leaden hue and a paleness on the Sun's disc.

[Margin: Quid differentiæ intercedat inter Cometam 1618 & 1652.] *What difference exists between the comet of 1618 and [that of] 1652.*

[Margin: Vnde Cometa 1652 pallidior extiterit Cometâ 1618.] *Why the comet of 1652 was paler than the comet of 1618.*

That the comet of the year 1652 did not possess equally dense and large nuclei came about, as far as can be gathered, from no other cause than that suitable matter of that kind was lacking; or that those vapours were at that time subtler and paler than others; or rather that the expirations of Saturn, Jupiter, Venus and the Moon, if I am not mistaken, prevailed in this comet, and these perhaps do not seek condensation as much as those of the Sun, Mars and Mercury do. For the Sun's matter above all, as is evident from the spots, is very prone to coagulate and condense, and, as it seems to us, is like a glue that binds together and unites the vapours of all the other planets. To the extent, therefore, that more or less of this solar matter flies together to the comet and adheres to it, to that extent the comet is made denser and more compact. But these things are gathered only by conjecture;

[Margin: Quantò plùs exhalationis Solaris Cometæ ineſt, tantò denſius compactiusq́; ejus corpus eſſe conjicitur.] *The more solar exhalation there is in a comet, the denser and more compact its body is conjectured to be.*

since they cannot be deduced. Just as it cannot be grasped with certainty why this or that spot of the Sun is larger and more solid than the rest, and why our clouds are not always equally dense and dark, it is no wonder, then, if those matters are likewise placed among the number of things that cannot yet be adequately perceived.

But the progression of the coagulation, augmentation, accretion, dissolution and decrease of comets will become much clearer still to everyone from the comet of the year 1661, famous for its varied and rare phenomena, which shone in the month of February; we have resolved, with God's help, to set out its observations and its whole history toward the end of this work. For I observed it twelve times, on different days, with an excellent and very long telescope, and each time I also sketched its face at once, properly and with the greatest attention. My purpose was to learn accurately the shape of the head, the arrangement of the nuclei, and also each change from day to day, and to show them to others devoted to celestial matters, as we have set out at greater

length in the general description of the same comet. From that description I shall now add here, only briefly, in what appearance it showed itself with respect to its matter, nuclei, light and colour, so that it may be understood the more readily how its head varied, and that I drew the likenesses of it placed in the preceding Figure not at my pleasure, out of my own head, but from the very sources of the observations.

[Margin: Ex Cometâ an. 1661 ortus & occaſusCrinitarum Stellarum adhuc clariùs cognoſcitur.] *From the comet of the year 1661 the rising and setting of the hairy stars is known still more clearly.*

Observations of the Comet of the Year 1661 [Obſervationes Cometæ anni 1 6 6 1.]

1. In the year 1661, on 3 February. The head was of a yellowish colour, bright and conspicuous, yet it had no twinkling light. In its middle it showed one dense and reddish nucleus, almost equal to Jupiter itself; this, however, was surrounded by far more dilute and thinner matter.

[Margin: Obſervation[[e/è]]s Cometæ anni 1661.] *Observations of the comet of the year 1661.*

2. On 5 February. The head [was] somewhat larger and brighter, of the colour of gold; its light, however, appeared gloomier than that of the other stars. But that single nucleus had already been cut into several parts, as the drawing of this day under the letter F shows.
3. On 6 February. The comet still showed almost the same colour, not unlike, though somewhat duller than, the colour that the star in the shoulder of Aquila displays at other times. The disc had partly decreased, and most of the nuclei were also smaller; one of them, in the lower part of the disc toward the left, was much denser and brighter than all the rest, with a round body, like some very bright little star. Other matter, as always, entirely surrounded these nuclei.

[Margin: In capite diverſi nuclei apparebant.] *In the head several nuclei appeared.*

4. On 7 February. The head departed a very little from its earlier appearance, so that that brighter nucleus was no longer so conspicuous; meanwhile, however, it was still of almost the same colour and size.
5. On 10 February. The head [was] now somewhat darker, and the nuclei more confused; yet I found them brighter in the lower part than in the upper. Its size otherwise, as far as the nuclei are concerned, was almost the same.
6. On 13 February. The head had decreased much, both in size and in brightness.
7. On 14 February. Seen with almost the same face as on the preceding day.
8. On the 17th. The comet was still of conspicuous size, even with the Moon shining; for its nuclei almost equalled the diameter of Venus. In respect of light and colour too [it showed] almost the same appearance, except that it showed [itself] somewhat turbid, and languid with dullness.

9. On 20 February. Because of the Moon's brightness the whole comet, together with its nuclei and the surrounding matter, appeared paler and more languid.
10. On 2 March. Still quite conspicuous, with a size of some minutes in diameter; yet it was not entirely round, and moreover it was torn and dispersed all around.

[Margin: Cometa non omninò rotundus apparuit.] *The comet did not appear entirely round.*

11. On 10 March. It displayed almost the same size, except that the whole body, with its nuclei, was duller and gloomier.
12. On 28 March. The comet [was] very pale and very thin, but above all it was greatly dispersed in respect of its matter, so that no nuclei at all were distinctly noticed, although its size had decreased little, as the sketches clearly testify.

[Margin: Quousq; Cometa 1661 fuerit obſervatus.] *Up to what time the comet of 1661 was observed.*

Now, in accordance with these observations, and with the archetypes taken at that time from the sky itself, I have depicted with the greatest care all the faces of this comet of 1661 in two lines, so that you may see and understand the more distinctly all its vicissitudes of coalition, accretion and dissolution, beginning from 3 February, namely with the letter E, when the comet was first observed, up to 28 March, namely to the letter R. On 3 February a single nucleus only, quite dense and very conspicuous, was found in the middle of the head, packed round with rarer matter. This nucleus, however, afterwards went off successively, as is evident from the drawings, into various parts and smaller nuclei, of which one appeared, compared with another, now brighter, now darker, now more solid, now thinner, perpetually changing their position relative to one another; so that they continually decreased and became darker and more dilute, until at last, the nuclei being dissolved and that rarer matter thinned, the comet not only presented a very pale face, but also, because of the thinness of its body, finally withdrew itself from sight entirely, just as the likenesses of this comet in the preceding figure clearly show. The first four drawings, however, namely A, B, C, D, were drawn not from observation but only at discretion, according as it seems this comet grew and increased from day to day.

[Margin: Initiò Cometa ex uno ſolo nucleo conſtabat; qui autem poſtmodum in diverſas partes abiit.] *At the beginning the comet consisted of one single nucleus, which, however, afterwards went off into various parts.*

But so that the matter may become clearer and clearer, come now, we shall attach to the preceding figure the period of one or another fictitious comet: namely, the way in which, as we conjecture, they are first born, then grow, decrease, and perish? And also how the coalitions, digressions, condensations and rarefactions of the corpuscles take place? Let the first of these comets be of the kind that consists of large and very solid nuclei, and is very bright and

very splendid; the other, however, of the kind that shines with a pale and dark light, as being composed of smaller and rarer nuclei and subtler matter. In the first you will see how, from its earliest age, that very rare matter from which comets take their beginnings is successively condensed, grows and increases; then degenerates into various nuclei, both smaller and larger; how likewise the nuclei gradually figure,

[Margin: Melioris intellectus gratiâ, Cometas quosdam fingere Autori placuit.] *For the sake of better understanding, the Author has chosen to invent certain comets.*

magnitude and solidity change; indeed, sometimes go off into one very vast body; again, by what way they are dissolved and thinned; in what manner they in turn decrease and diminish, and indeed in diverse ways, after the manner of the solar spots; and finally are reduced to the finest matter and dissipated.

In these paler comets, however, we likewise show their first origin: how they can be generated and dissolved, and how very wonderfully those expirations of the planets join together, separate, condense, extend and dissolve. This change and variation is almost infinite, so that hardly ever can one comet be similar to another in every respect; rather, of necessity they must be entirely different from one another, as much in figure, constitution and magnitude as in the solidity and rarity of their nuclei, as is always clearly found in the solar spots and in our terrestrial clouds.

[Margin: Vnde tanta variatio Cometarum exiſtat, atq́; adeò diverſi, quà faciem, appareant.] *Where so great a variation of comets comes from, and why they appear so different as to their face.*

From this generation, too, we gather without difficulty that the heads of comets can very rarely, except by some chance, be absolutely round or orbicular; rather, they mostly, and more often, pass into a varied, irregular form, a face which nevertheless, viewed from afar, appears for the most part round. Hence also it is not absurd that so very many species of comets can indeed exist, namely the shield-shaped [Clypeiformes], sword-shaped [Enſiformes], lamp-shaped [lampadiformes], horned [Cornutas], etc. (of which more fully in the next Book): that is, that the head is not always round, but [has] this or that form most similar to the things named.

[Margin: Cur Cometæ plerumq́; non omninò ſint rotundi?] *Why are comets mostly not entirely round?*

Next, from this hypothesis it is easily deduced that it can sometimes happen that comets, either while they grow or while they decrease, transform their face according to the proportion of the matter accruing, departing, consolidated and thinned: now into a round, now into an elliptical, or into any other figure whatever, according as the aggregation of the nuclei takes place in this or that part of the head. But why do comets not rarely not only appear nearly round but actually are so? It comes about from this, that Nature inclines above all to the circular figure, especially where some conjunction of corpuscles, or condensation of matter, occurs. And from this too more solar spots are found

of nearly circular figure than of triangular, quadrangular, quinquangular, or some other figure.

[Margin: Cometas, diverſam poſſe induere faciem.] *That comets can put on a different face.*

Yet do not suppose that this roundness is entirely spherical, much less highly polished; rather, it is rough, full of eminences and concavities, and indeed, like a disc, flat-round [plano-rotundam]. For these cometary bodies scarcely attain a fully spherical figure in any way, because of the diverse matter of diverse bodies of which they are mostly composed, which joins and unites itself only with great difficulty so as to coalesce into one wholly spherical or flat-round body. But since most comets consist of very diverse effluvia of diverse planets, the exhalations of each planet therefore long more for their own peculiar coagulation and condensation, so that, according to the diverse expirations, very diverse nuclei too are generated. These nevertheless by no means repel one another, nor resist, but seek one another most strongly and cohere easily, from a certain natural power implanted in them, up to their dissolution, attenuation and rarefaction.

[Margin: Cometæ non ſunt corpora abſolutè ſphærica,nec polita; ſed maximè ſcabroſa.] *Comets are not absolutely spherical bodies, nor polished, but extremely rough.*

But if a comet should at some time come forth into the light with one single, very dense nucleus, I would say that it had been generated from the exhalations of one planet alone, just as not rarely happens in the solar spots: although at first these are composed of many nuclei, they nevertheless sometimes pass into one solid [body], since they consist only of the same solar matter. Nonetheless, this body too is not absolutely spherical, but flat, extended and spread out, on account of the rarer matter adhering to that body, which the very swift motion given by nature to these bodies and to comets does not allow to come on equally around the centre. For that reason, rather, the supervening matter — namely the matter of the head (for with the matter of the tail, as you will soon perceive, things are arranged otherwise) — must accrue to this moving body only on the hinder side, or the fore side, or the upper or the lower side, but can by no means adhere on both sides. And so comets turn out to be bodies extended flat in figure, like a disc.

[Margin: Maculæ Solares non ſunt corpora ſphærica;ſed diſcea.] *The solar spots are not spherical bodies, but disc-shaped.*

But there is yet another, weightier reason why comets are by no means spherical bodies, but extended, or flat in form [planiformia]. First, one must know what has been sufficiently demonstrated by very many astronomers: namely, that the Sun is the centre of the universe, and so also of all the planets and of the Earth. Second, as we have said more than enough, and have often shown, the planets, like our Earth, constantly emit and breathe out their effluvia, from which comets are generated in their time. This matter, I say, as soon as it is thrown out from its bodies into the atmosphere, is at once extended like

terrestrial vapours and exhalations. These, however, are by no means raised [?] perpendicularly (with respect to their body, or to the centre from which they flowed out), in the likeness of planks set upright or of veils spread straight up, in which the upper parts are removed farther than the lower from the surface, namely of the Earth; rather, they extend themselves to the plane of the surface of their body. So it happens in our clouds and exhalations, which likewise do not stand erect upward like pyramids, but are equidistant from the surface of the Earth, that is, are stretched out to a flat surface. And so, in this situation, they also move continually away from their centre toward the periphery of their atmosphere, unless they are dissipated before they get there. The reason is this: in this way the clouds hang in the air more conveniently, spread out, that is, and lying upon the air with their flat surface.

[Margin: Cometæ inſtar Macular. ſunt corpora extenſa & planiformia.] *Comets, like the spots, are extended and flat-formed bodies.*

[Margin: Exhalationes æthereorum corporum, quâ ratione ex corporibus iſtis exeant, aſcendant, atq́; ſe ſe extendant.] *The exhalations of the ethereal bodies: in what way they go out of those bodies, rise, and spread themselves out.*

Moreover, the reason of clouds and exhalations[560] in the air is nearly the same as that of terrestrial things thinly spread out and lying in water. For example: you may push a small plank, whose length and breadth far exceed its thickness, into the water by some force, with its long side downward toward the bottom, so that it stands entirely upright in the water; yet it by no means obeys that direction. As soon as you have let the plank go from your hand, so that it comes under its own natural law, it at once throws itself onto one side or the other and lies on the water with its flat face. In this way it rests better, namely in the position where all its parts are equidistant from the centre of the earth and from the surface of the water.

[Margin: Quare aſſer in aquam rectà immerſus, erectus minimè conſiſtat.] *Why a plank plunged straight into water by no means stays upright.*

The reason is plain: the particles of the whole plank, above all the outermost ones toward either end, are in an inclined position some heavier than others; and therefore some of them, as against other parts, perpetually pre- ponderate, until they acquire equal weight; and this can by no means happen before they settle on the water with their flat face. For every outstretched thing also delights in its own centre of gravity (which usually lies in the middle, if it is of equal thickness and everywhere of the same solidity); and the farther the parts are removed from this centre, the more they weigh, pressing down or lifting up, by reason of the longer lever and the greater power, as statics teaches. Hence, as soon as this little plank, plunged straight into the water, perceives even the least motion, whether from the water itself, or the air, or some other supervening external motion, so that it leans and totters to this side or that, the upper parts at once outweigh the lower, until all the particles of the plank acquire equal

[560] the page prints exhationum; recte exhalationum

balance. They find this in no other position than when they lie along the flat surface of the water and are equally distant from the centre of the Earth; there, as in equilibrium and natural repose, they first come to rest. And so the plank cannot float on the waters except along its flattened surface, just as also happens with our clouds, exhalations and vapours in the air.

[Margin: Omnis res expanſa gaudet ſuo centro gravitatis.] *Every spread-out thing delights in its own centre of gravity.*

Who, I ask, would deny that the expirations and exhalations of the planets in the aether behave in entirely the same way with respect to their bodies and their atmosphere? But I would have you note well that, as long as the ethereal effluvia linger in their atmosphere, or vortex, so long does the matter there keep such an inclination and extension toward the centre of the body from which it came forth and flowed out, or toward the centre of the atmosphere in which it is then moving. In the vortex, however, these expirations perform a twofold motion: the one, namely, departing little by little from the centre, or from their body, toward the periphery of the atmosphere; the other, at the same time, moving themselves round in a circle according to the nature of their atmosphere, until at length these evaporations are cast out of that vortex and reach that most vast ethereal sea. Then, note, since they are no longer in its power, they are entirely freed from this circling motion of the vortex. As soon, therefore, as those exhalations, stretched out and flat in form, enter that most spacious ethereal field (unless they are already so constituted, as indeed for the most part happens around their exit, of which more fully in its place), they at once incline themselves so as to turn one or the other flat face, the more suitable one, toward the centre of the universe, that is, toward the Sun (which all the planets perpetually look up to and accompany, and around which they complete their periods), for the reasons brought forward above. And then that expanded comet matter directs its flat face toward the Sun in such a way, and always looks at it, just as before, while it lingered in the atmosphere and was enclosed in it, it presented the same face to its globe, or planet.

[Margin: Eodem omninò modo evaporationes æthereæ in ſuis atmoſphæris ſe habent.] *The ethereal evaporations behave in exactly the same way in their atmospheres.*

[Margin: Effluvia ætherea quales motus poſſideant in ſuâ atmoſphærâ.] *What motions the ethereal effluvia have in their atmosphere.*

[Margin: Evaporationes Planetarum extra atmoſphæram exiſtentes,ad centrum univerſi, hoc eſt, Solem ſe inclinant.] *The evaporations of the planets, once outside the atmosphere, incline themselves toward the centre of the universe, that is, the Sun.*

Since, therefore, that comet matter is stretched out in this manner toward the Sun, it must likewise always look at the Earth under a nearly similar inclination, excepting only certain cases and a certain very slight libration, of which below.

[Margin: Materia Cometica perpetuò faciem planam, Solem Terramq́; versùs exponit.] *Comet matter perpetually turns a flat face toward the Sun and the Earth.*

For since the Sun is likewise the centre of the great orb, or of the Earth, therefore, during the passage — if you except a few days, and those very rarely — comets perpetually present one or the other flat side of their face to the Sun and the Earth together, and always keep it turned toward them in the same way, whether they approach the Sun and the Earth more and more or are removed farther from them: just as this, by the diagram set beside, bet- ter understanding's sake, but only roughly, we have outlined: for in Book IX, where the passages and motions of comets will be treated expressly, these things will be set out more accurately.

Diagram. Concentric circles about the Sun, drawn as a rayed disc at the centre and lettered S. The circles are the orbs of the planets, each marked at its top with a planet's sign: from the outside in, Saturn, Jupiter and Mars, then the circle of the Earth, then Venus and Mercury. The Earth's circle, labelled along its right side "Orbis Magnus." (the great orb), carries dots lettered H, G, F, E, D, C, B and A, and two further unlettered dots on its upper left arc. At A stands a small circle marked "Terra" (Earth), with the sign of the Moon on its lower edge. At the far left, on the outermost circle, a small circle marked with the sign of Saturn and "Atmosphere [?]" sends out two straight lines: one rising to the right, "Linea Trajectoria Cometæ." (line of the comet's trajectory), and one falling to the right, "Linea Trajectoria. Cometæ." (line of the trajectory of the comet). Each line is crossed at intervals by short strokes, the position of the comet's flat face, and lines (dotted on the upper trajectory, solid on the lower) run from the Sun to the strokes. At the lower right is the engraver's signature "Autor ſculps." (the author engraved [it]).

- ♄ (top of the outermost circle): Saturn
- ♃ (next circle): Jupiter
- ♂ (next circle): Mars
- ♀ (inner circle): Venus
- ☿ (innermost circle): Mercury
- S (centre): the Sun
- H, G, F, E, D, C, B, A (dots on the Earth's circle, clockwise from the right): positions of the Earth
- Terra (small circle at A): Earth
- ☽ (edge of the small circle at A): the Moon
- ♄ (small circle at far left): Saturn
- Atmoſphæ[?]. (small circle at far left): Atmosphere [?]
- Linea Trajectoria Cometæ. (upper straight line): line of the comet's trajectory
- Orbis Magnus. (along the Earth's circle, right side): the great orb
- Linea Trajectoria. Cometæ. (lower straight line): line of the trajectory of the comet
- Autor ſculps. (lower right, outside the circles): the author engraved [it]

Let S be the Sun, the centre of the universe; the circles, the orbs of the planets; A B C D E F G, the Earth placed in different parts of the great orb.

From a higher orb K, that of Saturn for example, and from its atmosphere, let comet matter now be cast out into the aether, namely along the trajectory you see drawn. As soon, I say, as that matter is pushed out of the atmosphere, it at once directs itself, with its flat face extended, so that it always makes a right angle with a line drawn to the Sun, in every position and at whatever place of the trajectory; and hence its inclinations with respect to the trajectory constantly vary, so that it always presents a face set square [rectam] to the Sun, as is clearly seen from those shorter lines drawn on the trajectory. And in this way all comets (from whatever atmosphere they come forth, and into whatever part of the heavens they set out on their journey) always proceed: not, indeed, keeping the plane of the disc parallel to the trajectory, but inclined at various angles, so that they continually look at the Sun with one or the other of their extended faces, as we have said.

[Margin: Ratione autem quâ fieri posſit, Schemate dilucidatur.] *The way in which this can happen is made clear by a diagram.*

[Margin: Cometæ ſub diverſo angulo inclinationis reſpectu trajectoriæ incedunt.] *Comets advance at varying angles of inclination with respect to the trajectory.*

And the face they present to the Sun they then also present, nearly the same, to the Earth (unless the comets are in conjunction with the Sun): as is indeed sufficiently clear from the diagram, but will be plainer still in Book IX, to which I refer the reader.

This is about all we had to say for the present on the generation and corruption of comets. Now, before we turn to the remaining ques-

[Margin: De generatione,& corruptione novorum Siderum.] *On the generation and corruption of new stars.*

tions, we have thought it worthwhile to show briefly in advance how, in our view, the generation and corruption of new stars comes about. For it altogether seems to us that some difference exists between the generation of comets and that of stars. Indeed, just as comets are usually composed of countless, very diverse nuclei coagulated about different centres, and of the very diverse matter of the planets, and always come together into disc-shaped bodies, so, by contrast, new stars coalesce, condense and grow about one centre only, and consist of a single, very dense nucleus, and that a spherical one. For this matter, as far as can be gathered, is more uniform and more fluid, so that it can more easily be joined together and rolled into one round nucleus.

[Margin: Non eâdem planè ratione Cometæ, & novæ Stellæ naſcuntur.] *Comets and new stars do not come into being in entirely the same way.*

For the rest, comets are for the most part constituted by an aggregation of corpuscles and nuclei, whereas new stars grow only by the accretion of matter. This matter, by the nature implanted in it, flies together into one body, immovable as to place but movable on an axis about its poles, after the nature of the fixed stars from which the effluvia flowed out; so that the generation of stars takes place gradually, as we have said, about one centre only, and they grow

like stones, that is, by accretion, always remaining in the same place. Not that I deny that the matter can flow together from very diverse and innumerable fixed stars: indeed, from one single fixed star so much matter can by no means be supplied. For each of the fixed stars, as I reported above, has its own atmosphere, and they constantly breathe out effluvia, like the planets; these are sometimes cast out of those globes so abundantly that in the course of time some new star can be coagulated. But, in my judgement at least, such a generation is accomplished only over a long interval of time; indeed, a far longer time is needed to generate some new star than to produce a comet. First, because all the matter must come and flow together to a certain particular place, where that body begins to coalesce. Moreover, since these bodies are spherical, and indeed so far removed from us, they require much matter, which must surely grow to an immense size before it comes into our sight. Hence it comes about that new stars are by far the rarest phenomena of the heavens.

[Margin: Quâ ratione ex Fixis, Fixæ producantur.] *How fixed stars are produced from fixed stars.*

[Margin: Difficiliorem Novæ Stellæ habent nativitatem, quàm Cometæ.] *New stars have a more difficult birth than comets.*

Comets, by contrast, have a much easier generation, and for that reason, too, very many of them have shone since the foundation of the world. First, since they are not altogether spherical bodies but flat-extended discs, they are produced from far fewer exhalations. Then, because they arise about different centres and are built up from very many nuclei, and moreover for the most part by an aggregation of matter and corpuscles, they grow more easily into a mass. Above all, however, since comets enjoy local motion and often travel through a very great space of the aether, expirations from the atmospheres of the other planets therefore come to them abundantly from here and there, and are supplied to them. But just as these hairy stars are indeed generated more quickly, so they are also dissolved more quickly than new stars, which consist of one very large and very solid nucleus: for before such nuclei are consumed, whether by some intrinsic power or by the rays of the fixed stars, much time passes.

[Margin: Cometæ ſuper diverſis naſcuntur centris: hinc facilior eorum eſt generatio.] *Comets arise about different centres; hence their generation is easier.*

But to anyone who is not pleased by this opinion on the generation of stars I shall supply a quite different one, provided only it is supposed (as is also by no means foreign to reason) that each of the fixed stars moves in its own way in a peculiar orbit, whose centre, however, must necessarily fall outside the orbs of the planets. For in that way exhalations and evaporations can be breathed out and cast forth from the atmospheres of the fixed stars, just as befalls comets from the vortices of the planets, and can also move in a similar trajectory, in which they may grow and decrease. But is there not reason to think that this motion, attributed to the fixed stars, could produce some parallax? By no means. For the immense distance of the fixed stars from the Earth and the Sun in no way

permits it: even granted that the new stars depart from the bodies from which they were born as far as comets are otherwise usually removed from the planets, or from the Earth, yet no motion at all, I say, would be detected in them; rather, they would seem to rest constantly, as it were, perpetually immobile in the same place. For since the whole great orb [orbis magnus], viewed from the fixed stars, lacks any sensible parallax, those orbs of the fixed stars too, in which they must move, would certainly introduce no parallax, even if each of them were altogether equal in size to the great orb (if, that is, they were viewed in turn from the Earth and its great orb); and so, consequently, they would in no way be noticed to move either.

[Margin: Alia hypotheſis, pro generatione novarum Stellarum.] *Another hypothesis, for the generation of new stars.*

[Margin: Si Fixæ moverentur in ſuis orbibus, an parallaxin producerent ?] *If the fixed stars moved in their orbs, would they produce a parallax?*

Of these two different opinions you will now be free to choose whichever you wish, unless perhaps you have another ready to hand; and if that one is more consistent with reason, I shall not only yield but shall myself most gladly embrace it with both hands. For nothing ought to be held dearer than truth itself, in philosophical matters too, and all authority should rightly be ranked below reasons and observations. Indeed, whoever relies on the authority of this man or that, and already cherishes in his bosom a preconceived opinion about some matter, will, believe me, make no further progress at all in philosophical and physical matters. Nor will he ever be concerned whether something truer could be thought out or offered, so that in this way one might advance further still; instead he will labour with all his effort only at how an opinion once seized upon may be established more and more firmly. This, however, is to fit a greave to the forehead and a helmet to the shin, or to give the reason after the thing has been swallowed. Meanwhile, however, it is not altogether necessary that all the new stars which are seen to rise should either be created anew or be generated in a natural way; rather, they can come forth into view at a certain time: namely when, as we said above on p. 380, they free themselves from denser vapours and effluvia, the little clouds of evaporations and expirations by which they are sometimes covered having been dispersed.

[Margin: Nullius in verba jurare debet Philoſophus veritatis amans, ac rerum naturalium Scrutator.] *A philosopher who loves the truth and investigates natural things ought to swear by no one's words.*

[Margin: Poſſunt & aliâ ratione novæ Stellæ exoriri.] *New stars can also arise in another way.*

Now it is time to thrash out the remaining questions. First, then, it is asked whether comets, in decreasing to their end, use up as much time as they do in growing from their first birth up to their adult age. Certainly not. Rather, it is with comets just as with the solar spots: of these the greater part is usually found to be of the kind that grows suddenly but then wanes again very slowly; other spots, however, grow slowly and are consumed at once; others sometimes

coalesce and are dissipated over an almost equal interval of time: as by very many examples, unless pa-

[Margin: AnCometæ creſcendo, & decreſcendo, æquale temporis ſpatium conſumant ?] *Do comets use up an equal space of time in growing and in decreasing?*

per were being spared, it would be easy to demonstrate this. It is therefore certain that, in accordance with the matter supplied from the atmospheres, comets grow up, become established and fade away over unequal spaces of time.

And from this account of the increasing and decreasing matter (although motion also advances this very thing not a little, as will be shown in Book IX) it sometimes happens that comets now and then grow unexpectedly to a great mass and become very bright sooner than anyone would expect, when a day or two before, as sometimes befalls the solar spots, they had struck the eye either not at all, or barely, or not even barely. A most evident example of this kind is ready to hand in the drawing E above, p. 412, under number XV: namely in the spot *d*, observed by me here in Danzig in the year 1644, in the month of May. On May 8 it appeared very slight and thin; but soon, unexpectedly, on the 10th, that is the second day following, it had grown to an altogether astonishing size, so much so that the area of its disc, or of its greatest circle, was then found to be ten times larger than on the eighth day, and moreover far darker and more solid, and at the same time furnished with a very large nucleus; yet afterwards it decreased very slowly. A similar sudden change, seen by us in the spot *d* in the year 1643, in the month of August, is likewise drawn in the same drawing under number XIII. In Scheiner, in the *Rosa Ursina*, you will no less find not a few sudden variations of this kind: especially, for instance, around the spot *k*, in image XXVIII of the observations, which we likewise sketched under no. IV, Fig. D, p. 410. Likewise in the generation of the spot *b* and *c*, in Scheiner's image XXXVI of the observations: from a slender beginning it suddenly grew into a great mass on the very next day. In these cases something worth noting arises, which I have at last learned from the observations of many years: that, as a rule, all spots grow more quickly, and their nuclei gather together and consolidate, whereas they decrease, separate and dissolve more slowly. This is owing to a certain natural appetite, I judge, implanted in that matter, by which those evaporations coagulate and unite more easily and more quickly; and owing to a magnetic propensity, by which the nuclei are borne towards one another, they afterwards undergo dissolution or attenuation only with difficulty (since every natural thing strives to preserve itself). And this too, as it seems to me at least, is the chief reason why comets also usually arise so suddenly and increase very rapidly, and, on the contrary, diminish and vanish very slowly and gradually.

[Margin: Cometæ non rarò in molem immenſam excreſcunt.] *Comets not rarely grow to an immense mass.*

[Margin: Rariſſimum exemplum admirandæ alicujus maculæ Solaris ab Autore obſervatæ.] *A very rare example of a remarkable solar spot observed by the author.*

[Margin: Subitaneæ Macularum Solarium mutationes.] *Sudden changes of the solar spots.*

[Margin: Maculæ citiùs creſcunt,& tardius diſſolvuntur.] *Spots grow more quickly and dissolve more slowly.*

Second, it is asked whether every region of the heavens is suitable for comets to be created in, or whether they take their beginnings only in a certain part of the aether; and likewise whether they possess fixed limits within which they carry out their generations, as is customary with the spots. By no means. For they can be generated in every part of the aether, namely in the planetary system, and in any atmosphere whatever, wherever only sufficient and suitable matter is supplied. For they come forth now from the north, now from the south, now from the east, now from the west, and set out on their journey.

[Margin: An in quâvis Cœli parte Cometæ generentur ?] *Are comets generated in any part of the heavens whatever?*

That new stars, however, not rarely arise around the Milky Way has this cause: that innumerable fixed stars of the same age exist there, from which it is easier for some one new star to be generated than in a place where fewer are de-

[Margin: Quare in viâ lacteâ ſæpiùs novæ Stellæ exoriantur ?] *Why do new stars arise more often in the Milky Way?*

tected. For the Milky Way is nothing but a conglomeration of a great many very minute little stars, from which, certainly, more expirations and evaporations can be produced; and these can afterwards, owing also to the nearer distance of the bodies from which they are cast out, join together more quickly to compose so great a new body.

Third: since, therefore, it is granted that comets are begotten anywhere in the system of the planets, and that effluvia coagulate, it can sometimes happen that several are born at the same time, and indeed in very different places, being seen at the same time now in the same region of the heavens, now in an altogether opposite one. This has quite often been recorded by most trustworthy authors. 1. In the year of Christ 729, in the month of January, for 15 days, two were seen in the heavens, of which one preceded the Sun in the morning and the other followed it in the evening. 2. In the year of Christ 1214, in the month of March, likewise in Scotland, two appeared together, one preceding the Sun, the other following it. 3. In the year of Christ 1337 two comets are recorded to have arisen, of which one preceded the other by about the space of one month. 4. In the year 1529 four are reported to have appeared at the same time, standing opposite [one another]. 5. In the year 1618, too, two were observed, of which one, in the month of August, was very faint, while the other, in the month of November, shone most brightly upon the whole world: as Kepler attests, Ch. I, p. 47, *De Cometis*. Finally, also in the year 1652,

about the first rising of our comet, on December 15, as was reported in writing to Rome, not merely two but three were seen together in the West Indies; of these, however, only one came into the view of us Europeans in the following days.

[Margin: Quando ſimul duo Sidera crinita conſpecta fuerint.] *When two hairy stars were seen at the same time.*

[Margin: Quatuor Cometæ ſimul conſpecti fuerunt.] *Four comets were seen at the same time.*

Fourth: but at what time of year are comets usually generated? That is rightly asked here. Of this, however, nothing at all certain can be affirmed, no differently than of the generation of the spots. For these spots of the Sun are more frequent now in this year and month, now in that, so that none can ever be predicted. Likewise comets are bound to no fixed time, but every part of the year is equally suited to producing them. Some indeed hold, such as Franciscus Junctinus [Francesco Giuntini] in his *Speculum Astrologicum*, *De Cometis*, p. 316, and also Simon Majolus [Simone Maioli] in the *Dies Caniculares*, Colloquy 1, p. 5, that they are more frequent in autumn; others again in the summer season; others in spring. But they are certainly far wrong. For, as we have said, they are generated at any time of year whatever, and in the winter season too: as is sufficiently clear from our History and Chronological Table of Comets, and above all from the comet of the year 1652.

[Margin: An Cometæ certo anni tempore tantùm producantur ?] *Are comets produced only at a fixed time of year?*

If each and every comet had been recorded since the foundation of the world, something could perhaps be established with more certainty on this matter: namely, whether more had come forth in this month or in that; although even knowing that would not yet suffice. For a great many first see the light beneath the Sun's rays. Not a few, likewise, of those produced from the atmospheres of the other planets without any doubt quite often make straight for the Sun, so that for their whole duration they lie hidden beneath the rays of the Sun, almost in conjunction, and never come into our view. Moreover, others of them are sometimes removed so far from the Earth, when they direct their course towards the periphery of the planetary system, that they can neither be sufficiently illuminated by the Sun nor be seen by us. Very many, too, owing to the matter's tenu-

[Margin: Non omnes & ſinguli Cometæ in oculos incurrunt.] *Not each and every comet strikes the eye.*

ity and the body's slenderness, altogether elude the keenness of the eyes. Others again are snatched from us because the sky is quite often cloudy, in accordance with that saying of Seneca, *Natural Questions*, Book VIII, Ch. 30: *How many things go on in secret, never rising to human eyes.*

Since, then, only some, or rather very few, strike the eye, we can draw nothing certain from this; instead we must rest content with this opinion: namely, that the time of origin of comets, and of new stars, is not certain and

determined. For just as they arise in any place of the heavens, so they arise in any part of the year, in spring, autumn, summer and winter; as Seneca rightly judges, in the book just cited, Ch. 12: *Comets are seen everywhere. They have no more a fixed time at which they appear than any place beyond which they do not go.*

Meanwhile, however, I shall readily grant that comets can be brought forth more easily and more quickly at the time of the great conjunctions of the planets than at any other. To some, however, this will seem to smell of astrology, and they will no doubt wonder that I attribute so much to astrological trifles of this kind; yet I set little store by those vanities, not being unaware how much astrology is to be valued and how far its powers extend. And yet it cannot be denied that, according to nearly each and every expert in astrology, comets must necessarily appear at the time of the great conjunctions and of certain aspects. Franciscus Junctinus also holds this in his annotations on comets, and indeed at the time of the conjunction of Saturn and Mars; others, however, at the time of the conjunction of Saturn, Jupiter, Mars and the Moon, especially if these fall at eclipses of the luminaries. But Cornelius Gemma, *Cosmocrit.*, Book I, Ch. VIII, p. 206, rules on this matter as follows: *Indeed* (he says) *I find by diligent observation that torches of this kind are mostly born from the stations of the three superior [planets], Saturn, Jupiter and Mars, if ever they fall into mutual syzygies, especially if one of them is found in the fiery signs, or not far from the Milky Way, or with fixed stars of the nature of Mars or of the Sun, of the first, second and third magnitude. Indeed, the stations alone in each single system have the greatest effect, and instil long-lasting powers. All this, moreover, is confirmed by the testimony of Mercury, if it is added, and most of all by eclipses, or the graver failures of the lights: especially when they fall at the beginning of Aries or of Libra, where other portents of the same signification have also concurred.*

[Margin: Stellæ atq; Cometæ, tempore magnarum conjunctionum, procliviùs naſcuntur.] *Stars and comets are born more readily at the time of the great conjunctions.*

That comets, then, have not rarely been born at the time of conjunctions is likewise shown by many examples indeed. 1. Namely, by the comets (to say nothing of the others, which are older) of the years 1504 and 1506, which appeared shortly after the great conjunction in Cancer. 2. In the year 1525 a great conjunction occurred, and behold, immediately in the following year, 1526, a comet like a fiery sword flashed forth; as another had also done shortly before, namely in the year 1521, when Mars likewise was then coming to the conjunction. 3. Around the following great conjunction, of the year 1544, two comets shone, namely in the years 1539 and 1543. 4. In the year 1564 a great conjunction; and again a comet appeared in the years 1560 and 1569. 5. In the year 1577 a remarkable comet shone forth in the month of November, at a time when no great conjunction, namely of Saturn and Jupiter, took place; yet nearly all the other planets were closely conjoined in one and the same sign, and indeed in the month of September, and Saturn too was not far from them at that time.

[Margin: Exemplis probatur.] *It is proved by examples.*

6. In the year 1583 a comet [was] seen around the great conjunction. 7. In the year 1603, after a second conjunction, a new star came forth in Serpentarius. 8. In the year 1618 a comet [was] detected shortly before a great conjunction. 9. In the year 1643, again a great conjunction; likewise, too, in the year 1647 a comet appeared. In the year 1661 a notable comet flashed forth in Aquila; and in the following year, 1662, that famous gathering of nearly all the planets in Sagittarius; and in the year 1663 a great conjunction occurred again.

To this extent, then, I do indeed agree with the astrologers: that comets are for the most part brought forth at the time of the conjunctions of the planets. But as to where this comes from, on that I disagree with them entirely. The astrologers judge that at that time exhalations and vapours can be drawn out of the Earth in greater abundance, supposing that all comets are sublunary. But in truth the matter stands far otherwise, and an altogether different reason, to be drawn from our hypothesis on the generation of comets, underlies it here. I say, moreover, that there is a very great reason why comets can be generated more quickly at the time of the conjunctions of the planets than at another [time]. For when most of the planets are in conjunction, or not far from one another, they are certainly much nearer to one another than when they stand in opposition or in any other aspect. Hence it comes about that at that time those effluvia, if they then happen to be breathed out from those bodies in such abundance, are able to join and gather together much more quickly too, to coagulate a comet, than when they are more remote. Moreover, the nearer and the more conjoined the ethereal bodies are, the more strongly they act to expel evaporations and expirations. Indeed one must readily grant that the planets can extend and exercise their powers no less upon one another than upon the Earth; and so it is very likely that, when their operations are intensified, they then also emit exhalations more readily, as is evident in the Earth and in the Sun. For the Earth at one time stirs up and expels exhalations and vapours more vehemently [than at another], to form clouds and to produce rain, snow, earthquakes and other meteors; the Sun likewise is found at one time more fertile and more apt [than at another] for bringing forth spots, faculae and shadows, as experience confirms. From this we can conjecture nothing other than that at a certain time, especially that of the conjunctions, when the powers of the planets are more keenly intensified, exhalations are supplied more copiously and gather together more easily, and comets can sometimes burst forth more promptly.

[Margin: Autor ab Aſtrologis in hypotheſi vald[[è/é]] diſſentit.] *The author strongly disagrees with the astrologers on the hypothesis.*

[Margin: Quâ ratione,ex ſententiâ Autoris, Cometæ citiùs exoriantur tempore magnarum conjunctionum.] *For what reason, in the author's opinion, comets arise more quickly at the time of the great conjunctions.*

Yet I would not have you take this as though comets must necessarily be produced at every time of the great and other conjunctions of the planets,

as indeed most astrologers hold, on no grounds. For it is certain that they have sometimes come forth at other times too. For those most subtle ethereal expirations wander abundantly and constantly this way and that through the whole heaven, and, according as they are borne towards one another, they coagulate and condense now more quickly, now more slowly. So comets have no prescribed and definite time, as I related a little earlier; and therefore they can in no way be predicted, even though those devoted to astrology hold the contrary. But, you will say, these men have nevertheless often foretold comets? I admit that they have sometimes delivered such an oracle; but certainly not except

[Margin: An neceſsariò tempore magnarum Conjunctionum Cometæ appareant?] *Whether comets necessarily appear at the time of the great conjunctions?*

[Margin: Cometæ neutiquam prædici poſsunt.] *Comets can by no means be predicted.*

by chance does this happen; indeed, if you remember rightly, they have quite often predicted phenomena of this kind when none at all occurred. But for the most part it usually happens with those people who are keenly devoted to the judicial art that they diligently note and celebrate it when in one or another case they hit the mark, even if only by sheer luck; whereas, though they go astray six hundred times, it is not held against them but is rather wrapped in deep silence. But mark what Cardano himself, otherwise a distinguished and ardent astrologer, judges of astrological predictions, Ch. VI, p. 68, *De Judiciis*: *Of forty things, scarcely ten come to pass.* But Gassendi answers this still more truly in his *Animadversiones* on Diog. Laërtius, p. 972, *De Signific. Siderum*: *But if love of his art had not still bewitched the man* (Cardano)*, he ought rather to have said: of four hundred, scarcely a single one.* But enough of this, lest I seem to provoke and irritate the astrologers and so expose myself to their hatred; let us return to the point from which we digressed.

[Margin: Quid illis eveniat,qui Aſtrologiæ impensè favent.] *What happens to those who are greatly devoted to astrology.*

[Margin: Cardani & Gaſsendi de rebus Aſtrologicis judicium.] *The judgement of Cardano and Gassendi on astrological matters.*

Fifth: it must now be investigated whether all cometary matter, cast out of some atmosphere and in some manner coagulated in this or that part of the ether, grows continually in such a way that it at last becomes visible to us. Even if this matter comes together in a place where it is above the horizon at night, it nevertheless quite often escapes our eyes, because sufficient matter is not always supplied for it to grow continually; and so, before that body reaches maturity and its due size, it is dispersed in turn, especially if it begins to coalesce in the far-distant spheres of Saturn, Jupiter and Mars. This is entirely after the example of the solar spots. Very many of them, certainly, take their beginning on the Sun's disc from some very dilute matter, but very often they grow little or not at all, much less acquire visible nuclei; rather, before they reach even some degree of perfection, they are consumed again within the space of a few days,

and indeed sometimes of a few hours. Sometimes, like a very faint shadow, they linger for a day or two while moving forward, and so vanish: one of this kind was noted by us in the year 1643, on September 2, *Selenographia*, Appendix, p. 509. Likewise spot *h*, p. 524. In Scheiner innumerable such spots are found, for instance in Image XXV, spot and facula *i*, p. 214, Book III of the *Rosa Ursina*; of this the author himself says the following: *Spot* i, *very small, first arose on June 7, stretching out a facula towards the south like a comet; after June 10 it perished completely, and never afterwards gave back anything.* Further, on p. 233, at spot *d* and shadow *g*, he noted this: *The spots and faculae* d *lasted three days; but the two shadows* g *adhering above lasted only half a day, which [is] an everyday thing for this phenomenon.*

[Margin: Non ex quibusvis effluviis, & evaporationibus æthereis illicò Cometa generatur.] *A comet is not generated at once from any ethereal effluvia and evaporations whatever.*

[Margin: Maculæ Solares brevisſimæ nonnunquam ſunt durationis.] *Solar spots are sometimes of very short duration.*

This certainly happens to comets too, so that not a few of them both coalesce and are dispersed again before they acquire any notable substance. Such comets, moreover, are rightly called secondary, by analogy with the fainter spots that are present on the Sun's disc at almost all times but are scarcely, if at all, detectable. I am almost persuaded that comets of this kind occur in the ether too, at any time, if only they could be detected as distinctly as the secondary spots. For these, being exposed to the light, that is, in the bright-

[Margin: Quid ſint Cometæ ſecundarii.] *What secondary comets are.*

est disc of the Sun, appear like shadows; but those comets must be seen outside the Sun, in the ether, entirely deprived of the Sun's light, since at that time they are not yet fit to receive and reflect that light; and therefore they do not come into view at all, but move in concealment. Indeed it seems likely that only very rarely do so many vapours and exhalations come together during the passage [of a comet] for so many nuclei and so great a mass visible to us to be built up. Why then do we wonder that comets are such rare phenomena of the world? although at different times they are more frequent. In this current century only five or six have appeared; by contrast, in the century just past, thirty, more or less, appeared. How many have been observed, both by mathematicians and by historians, from the very beginning of the world, our Chronological Table of Comets, to be added at the end of this work, will fully show.

[Margin: Quare hi Cometæ oculos noſtros plerumq́; fallant.] *Why these comets mostly escape our eyes.*

Sixth: since the most subtle expirations of the planets, as was said a little earlier, wander here and there in the ether and are dispersed this way and that, you will surely say: will they cause us some refraction? But there is no reason for you to fear this. For, first, that matter, before it is condensed, is so subtle and thin that it allows the rays an entirely free passage, and so they all pass through

unrefracted. Next, even supposing that those expirations gradually thicken a little, they nevertheless at first subtend so very small a space of the ether that they can by no means be perceived. For if the bodies themselves from which they burst forth are scarcely of one minute in diameter, tell me, I ask you, how much space will its evaporations occupy? Will it not be a thing of no account at all, which comes into no consideration whatever and is scarcely able to veil any star completely? Indeed, even if by sheer luck they should wander in such a way that they sometimes place themselves at the same time before some star and before our eyes, they will nevertheless scarcely be detected; for, because of the motion imparted to those effluvia, they would soon leave the star again, so that nothing exact could be established about this matter.

[Margin: An Planetarum effluvia nobis adſpectus diverſitatem aliquam inducere poſſint ?] *Whether the effluvia of the planets can cause us some parallax?*

Moreover, we have found more than enough that the terrestrial exhalations and vapours, with which our air constantly teems even around the zenith, introduce no refraction at all. From this it is easily gathered that these ethereal expirations too cannot refract the rays. This is proved still more clearly from those secondary spots and very faint shadows that beset the Sun almost constantly, since they certainly exhibit no refraction at all greater than the ordinary one. Granting, besides, that the rays can sometimes be corrupted at their own time, I nevertheless scarcely think it is to such an extent that it could be noticed in any way, even with far more perfect instruments. But suppose that some refraction does strike the senses as those evaporations run across, and is even detected with instruments: who, I ask, will observe, or be able to observe, at exactly the same moment that very same star among so many innumerable ones, since he does not know where those ethereal exhalations are lingering? I am persuaded that one could scarcely come upon them by chance. Moreover, of all those who devote themselves to observing the stars, has scarcely one or another of them appeared within a thousand years and more who explored the heavens with suitable instruments and due diligence? Indeed, even if, by sheer luck, some one person at that time, that very star which the ethereal expirations over-

[Margin: Etiamſi detur ob iſtas evaporationes refractio, nullâ tamen ratione obſervari poteſt.] *Even if refraction occurs because of those evaporations, it can nevertheless in no way be observed.*

[Margin: Paucisſimi hucusq́; extiterunt, qui inſtrumentis idoneis Sidera rimati ſunt.] *Very few have so far existed who explored the stars with suitable instruments.*

fly, should observe it and perceive some difference of refraction, he will nevertheless by no means attribute it to those evaporations, since they wholly escape the keenness of the eyes; rather, he will put this extraordinary refraction, if any is found, down to air thicker than it should be, or ascribe it to the negligence of the observers. For since the effluvia are in continual motion, it can very easily happen that they immediately leave the clouded star again, so

that when the observation is repeated he notices only the ordinary refraction. Therefore, even if the rays of the stars could sometimes be corrupted by such ethereal mists and little clouds passing suddenly across, it is nevertheless in no way possible to investigate this very thing exactly: which was to be proved.

Seventh: it is asked whether comets, while advancing by their proper motion in their trajectory, at the same time rotate about their centre, that is, upon an axis? No doubt you are persuaded that comets, existing in the same medium, likewise turn round, just as the planets do; but the matter stands entirely otherwise. I grant most willingly, as has already been touched on, that the planets, except the Moon and the arms of Saturn, are continually turned about on an axis; but very different reasons underlie why the planets enjoy this motion, while comets do not at all? For if the planets did not protect themselves by the motion of rotation, that huge sphere of the Sun, which is a true and real fire, would dissolve those bodies by its power; but by this motion they are preserved in their condition, so that they are entirely indissoluble. Add to this that the bodies of the planets, if they did not turn round, would perpetually turn one and the same face towards the Sun and expose it to its rays. That would be most absurd: to be steeped in the Sun's light on one side only, to lack it entirely on the other, and to have the averted hemisphere wrapped in perpetual darkness; and so those globes would undergo none of the vicissitudes in which universal nature otherwise greatly delights. But you may object: why does the Moon not likewise possess a rotatory motion? I will say: because, through the monthly motion that it performs around the Earth, it is lit by the light of the Sun on every side each month, so that it has no need of that motion of rotation. For as nature most eagerly seeks what is necessary, so, conversely, it utterly abhors what is superfluous.

[Margin: An Cometæ circa axem gyrentur ?] *Whether comets rotate about an axis?*

[Margin: Cur Planetæ circumrotentur ?] *Why the planets rotate?*

[Margin: Cur Luna non inſtar reliquorum erronum motu gaudeat circumgyrationis.] *Why the Moon does not enjoy the motion of rotation like the other wandering stars.*

Moreover, whatever bodies have to rotate must be perfect, perpetual, whole, entirely globular, and set in their own natural place; and since the planets are such, they can certainly turn round. Comets, by contrast, since they are bodies imperfect in nature, temporary, not spherical at all but only disc-shaped, and then only parts or effluvia of the ordinary ethereal bodies, and likewise particles expelled and thrust out of their own proper natural place, therefore in no way rotate about an axis, nor are they suited to turning round. Indeed, whatever parts have been torn away from their whole and now move outside the place assigned to them by nature are by no means subject to rotation, as we have said, but are borne only along a straight path; and this motion is more suitable, by reason of the centre of gravity, to bodies formed in the shape of a disc. Next, since in this way comets almost always turn the same face towards the Sun,

apart from a certain very small libration (of which in its place), the bodies of comets are therefore by no means eternal, but in time are easily dissolved and dispersed again, so that they may at last return to the bodies from which they flowed out. To these comets, plainly

[Margin: Quibus corporibus tantùm competit motus in axe.] *To which bodies alone motion on an axis belongs.*

[Margin: Cometæ ad motum circumrotationis minimè f[[i/u]]nt apti.] *Comets are [?] not at all suited to the motion of rotation.*

the same thing now happens as to our clouds and to the spots of the Sun. Since these are likewise parts of their own bodies, and moreover are extended and perishable bodies, they are therefore driven only with a straight motion (if you except the diurnal motion of the Earth and the monthly motion of the Sun), performing nothing but a certain libratory motion. So far as I know, this motion has not yet been noted by anyone in the case of the spots; but it will be very easy to demonstrate it in due time.

[Margin: Corpora diſcea motu tantùm recto moventur.] *Disc-shaped bodies move only with a straight motion.*

That comets, moreover, by no means rotate about a centre is likewise proved from the fact that they are not seen continually under the most varied appearance; rather, the appearance they once present they retain almost constantly through their whole duration. For since they are entirely disc-shaped bodies, as has been more than sufficiently demonstrated, they would therefore appear much slenderer and plainly elliptical around both their first and their last appearance, when they are farther from us and are seen under a more acute angle. Yet they would also change that appearance as they approached the Earth, on account of the more oblique and more direct aspect and the smaller and larger angle of vision, coming closer and closer to roundness, until, with respect to us and to the Sun, at a right angle, they would be seen as circular as could possibly be. But this is by no means found in comets; therefore they do not rotate, but proceed along their trajectory with an almost unchanged face.

[Margin: Quare Cometæ non rotentur.] *Why comets do not rotate.*

Furthermore, if that gyratory motion were attributed to comets, the tail too (which arises from the refraction and reflection of the solar rays, as will have to be proved in the next Book) would necessarily take on a most varied form from day to day, indeed from hour to hour. It would never show so constant a form as it usually does, but would continually be made, by reason of the turning of the body towards the Sun, now shorter, now longer; now rarer, now denser; now straighter, now more curved; now blunter, now more pointed; now brighter, now duller. Indeed it would sometimes vanish entirely and unexpectedly: namely at the time when both flat faces were turned away from the Sun. But soon that very tail would burst forth again, showing the same face in succession, that is, if this circular motion were regular, perpetual and continuous; but if it were unequal and anomalous, then, believe me, the tail would also undergo corresponding changes, and indeed according as the period

of rotation was either quicker or slower. Yet such a sudden metamorphosis is never observed in the tails (even if they are subject to some change, as will be said in the following Book), but only a proportionate variation, by reason of the distance and of the constitution of the nuclei. Therefore neither comets, nor in particular their corpuscles and nuclei, of which they are composed, are driven round in a circle: which was to be demonstrated.

[Margin: Aliud argumentum, quòd Cometæ circa axem non moveantur.] *Another argument that comets do not move about an axis.*

Lastly: since, therefore, comets are by no means subject to rotation, it also follows that they cannot flash or twinkle at all, but shine always with an even light, which they draw entirely from the Sun. So the most skilful Cornelius Gemma [Cornelis Gemma], no common investigator of celestial things, has likewise noted in his book *On the Divine Characterisms of Nature* [de divinis naturæ characteriſmis], Book II, Chapter III, page 129: "No comet," he says, "has ever been seen to strike the sight with a twinkling light, but always gloomy and mournful, with a tranquil efflux"; unless perhaps it hangs in a very much lower position, filled with denser vapours. For every celestial body,

[Margin: Quare Cometæ non ſcintillent; ſed triſti & lugubri facie pleruńq; appareant.] *Why comets do not twinkle, but for the most part appear with a gloomy and mournful face.*

that twinkles necessarily both rotates and is girded by a vaporous sphere; or at the very least the corpuscles and nuclei of which the comet's head consists must move vehemently relative to one another and change their position. Then, if fresh matter from time to time frequently clings to the body as it passes through, it can sometimes happen that comets then flash: as was detected in the comet of the year 1618 on December 4, as Cysat reports, Chapter V: "The head of the comet," he says, "twinkled rarely and faintly"; but of these things more fully in Book VIII.

[Margin: Quando rursùs Caput Cometæ corruſcet.] *When, again, the head of a comet flashes.*

I do not deny, indeed, that comets are surrounded by an atmosphere, or by very dilute evaporations, from their first rising until their end, as will also have to be shown in the following Book. But since the bodies or nuclei that make up the comet's head by no means rotate together, and consequently the atmosphere does not rotate either, no twinkling, or vehement reflection, or vibration arises from that source. For, as you have learned, two things together are required for twinkling: namely a surrounding vaporous sphere, and the rotation of the body and of the vaporous sphere; this is required of necessity. For this reason the Moon too does not twinkle: because it is not driven round in a circle, but shines almost always with the same face.

[Margin: Cometæ etiam ſuas habent atmoſphæras.] *Comets too have their own atmospheres.*

[Margin: Quænam ad ſcintillationem neceſſariò requirantur.] *What is necessarily required for twinkling.*

But you may object that the Sun and the other planets, which have an atmosphere and at the same time are carried round on an axis, are sometimes free from twinkling? I admit that this is entirely so; but the reason is ready to hand: namely, those vaporous orbs by which they are enclosed are filled more with finer vapours and expirations at one time than at another. For even if the effluvia rising into the atmosphere are thick enough, certainly no vibration of the light can be noticed. Accordingly we also detect that agitation of the rays only about the limb of the Sun, that is, near the horizon, which denser exhalations mostly beset, and indeed only with the aid of telescopes; with the naked eye, by contrast, nothing at all of twinkling is perceived, because of the Sun's most dazzling splendour.

[Margin: Cur Sol non ſcintillet[[./,]]] *Why the Sun does not twinkle.*

With the new stars, however, something different happens, as it seems. For since they are entirely globular bodies, like the other fixed stars, consisting of a single nucleus, I think that they are not only surrounded by an atmosphere but also rotate on an axis about their poles. For observations prove that they all twinkle, and emit rays flashing from the body, as the coeval bodies of the fixed stars do. The great Tycho agrees, on the new star of the year 1577 in the constellation Cassiopeia, Book I, Chapter III, page 300: "This star," he says, "had a round form, in no way unlike the other lights of the heaven; for it shot out no tail or hair, either towards some one part or all round, as is usual in comets, but, like the other stars, it emitted rays flashing from its body, as happens in the larger stars, and that with a quite twinkling vibration of light, almost more than is seen in the other stars." Likewise Kepler [agrees], in his little work on the new star of Serpentarius, Chapter I, page 5: "On the appearance of the star, all who kept watch at its first rising agree that it was exactly round, with no hair, no beard, or train thrown out in any direction; so that it is to be counted in no species of the hairy stars, neither the Pogonias nor the comets, but [was] most like the fixed stars, with rays shooting out on all sides, like those of the fixed stars; with a most brilliant twinkling, a flashing or vibration so rapid that they indeed denied that, as long as they lived, anything had ever been seen by them in the heaven,

[Margin: Omnes Fixæ corruſcant.] *All fixed stars flash.*

[Margin: De novâ Stellâ in Caſſiopeâ.] *On the new star in Cassiopeia.*

[Margin: De novâ Stellâ in pede Serpentarii.] *On the new star in the foot of Serpentarius.*

with an equally swift motion, as they themselves put it." Likewise it is clearly evident to all who raise their eyes on high to those two new stars still existing in the heaven: namely, that both the one in the breast of Cygnus and the one most recently returned again in the neck of Cetus shine with rays flashing on all sides; yet the one surpasses the other in twinkling, by reason of a denser atmosphere and a swifter rotary motion. Anyone who has attentively watched these two new stars, now and formerly, will likewise readily admit this.

[Margin: Novæ Stellæ ſemper ſcintillant.] *New stars always twinkle.*

And these are roughly the things we wished to say about the origin and passing away of comets and about the matters bearing on it. We confess that we have been rather long-winded; but this lofty and subtle matter could hardly, indeed, have been discussed otherwise. We have therefore shown clearly enough, I think, according to our slender ability, how the generation, progression, growth and diminution, and likewise the dissolution and corruption, of all comets proceed. Above all, we have clearly deduced that it is almost the same with comets as with the solar spots in respect of generation and dissolution; moreover, that almost the same properties or affections, apart from a very few, belong both to the spots and to the comets; and that comets are to be likened to nothing rather than to the spots themselves. But, to set the matter out still more specifically, come, let us now consider attentively all those assertions about the spots inserted on page 408, and indeed in the order in which they were given. In this way, before an end is put to this Book, we may see still more accurately in what respects they agree entirely; and then we may present all those things that were said at length above about the origin and passing away of comets, gathered in a kind of compendium in certain aphorisms that follow.

[Margin: Cometæ & MaculæSolares ſimiles habent affectiones.] *Comets and solar spots have similar affections.*

1. Whatever [is said] about the spots in the first assertion is likewise rightly said of comets: namely, that comets claim for themselves both a physical and an astronomical rising. For some are both generated and dissolved again in the visible hemisphere. Comets of this kind appeared in the year 1585, in the months of October and November, and likewise in the year 1590, in the months of February and March, so that these accomplish both their rising and their setting in our open hemisphere. Others, however, are indeed born on our horizon and in any part of the heaven, but, hastening towards the horizon, they set for us astronomically, or are hidden by the rays of the Sun; so that they are snatched from us sooner than would indeed have happened if they had avoided the Sun's rays in their course. A clear example of this is at hand in the comet of the year 1647. For the most part, the more easterly comets advancing against the series of the signs, and likewise the more westerly ones tending along the order of the signs with an especially swift motion, are swallowed up by the Sun sooner than expected. Among these are rightly counted those that have a physical rising and an astronomical setting. Others, again, have only an astronomical rising and a physical setting, as was observed in the comets of 1577 and 1618, and also in our own of 1652. Of those, however, that have an astronomical rising and setting, very few occur; for they rarely last that long, but for the most part are dissolved before they reach the western horizon. To others, in turn, it is granted neither to rise nor to set astronomically, but only physically: namely those that are both coagulated and dispersed above the horizon. However very many

of these may perhaps occur among the Antipodes, they are nevertheless rather rarely no-

[Margin: Aphoriſmi Cometarum.] *Aphorisms of comets.*

[Margin: Cometæ tam ortumPhyſicum quàm Aſtronomicum ſibi vendicant.] *Comets claim both a physical and an astronomical rising.*

[Margin: Quinam Cometæ ſpe citiùs abſorbeantur:] *Which comets are swallowed up sooner than expected.*

[Margin: Duo Cometæ in Indiâ occidentali viſi anno 1652.] *Two comets seen in the West Indies in the year 1652.*

ted: into their number must be reckoned those two that were visible only in the West Indies on 1652 December 15; and also those that raise only their tail above the horizon, their head remaining hidden throughout their whole duration. An example of this kind appeared in 1618, around the end of November, as Kepler reports, page 47, *de Cometis*.

2. Just as the spots [are formed] from somewhat thicker matter of the Sun, or from denser effluvia, so comets are formed, grow and decrease from the finer evaporations of various planets, and very rarely from those of a single globe.

[Margin: ExPlanetarum effluviis Cometæ producuntur.] *Comets are produced from the effluvia of the planets.*

3. Comets too possess a threefold age: first a green one, namely when they grow up and increase; second a mature one, when they arrive at the ripest strength of their age; and third and last a declining one, when they decrease and fade away until they are entirely consumed. This is also divided as follows: namely into the time of increase, of standing, and of decrease, both physical and optical, as happens in the spots; except that, by reason of optics, those phenomena arise from an entirely different principle. In the spots, indeed, they arise from the fact that those flat, extended bodies seem to move as it were in a circle; in comets, however, from the fact that they advance in an almost straight line. As a result, the longer apparent diameter varies not so much in comets as it does in the spots, as will be shown more fully in Book IX.

[Margin: Cometæ triplicem habent ætatem.] *Comets have a threefold age.*

4. The fourth property of the spots also belongs entirely to comets, but with this express condition: that the increase, together with the optical decrease, does not claim for itself a fixed place, just as [it claims] no fixed zodiac, after the manner of the spots, in which they are generated. Unless you understand the contraction and dilatation of the cometary body in this way: that in more remote places the dilatation is always least, but in nearer places greatest. Of this we shall likewise speak at length in due time. The aphorism will therefore have to be framed [?] as follows: The increase and decrease, physical as well as optical, takes place not in some fixed part of the heaven but in any part whatever, and indeed continuously, successively, gradually and unequally. Hence it happens

that sometimes a comet that grows slowly and is more durable fails all at once; conversely, one that shines forth suddenly persists for a long time and is dissolved slowly and gradually. Sometimes one grows and condenses faster than expected, and likewise decreases and is reduced into shadows, or the subtlest ethereal air; another, by contrast, does so slowly.

[Margin: Cometæ nullum habent Zodiacum,ut quidem Maculæ Solares.] *Comets have no zodiac, as the solar spots indeed do.*

5. Comets, like the spots, are generated and increase by the concourse of like matter to like, by condensation, adgeneration, substantial generation, and the aggregation of many very minute bodies, or nuclei; again, in the contrary manner they diminish and perish.

[Margin: Quâ ratione generentur, creſcant, ac decreſcant.] *How they are generated, grow and decrease.*

6. Comets, just like the spots, are bodies by no means spherical but flattened, yet of differing thickness: sometimes presenting roughly regular round figures, sometimes irregular figures of any kind whatever.

[Margin: Sunt corpora diſcea.] *They are disc-shaped bodies.*

7. Comets, like the spots, are extremely diverse and unequal, as much in figure, size and thickness as in colour, obscurity, density and rarity.

[Margin: Cometæ ſunt admodùm diverſi.] *Comets are very diverse.*

8. No less do they possess nuclei of the most diverse size and thickness, density and colour.

[Margin: Habent nucleos.] *They have nuclei.*

9. The nuclei of comets likewise grow and decrease: from small they gradually become large, and in turn, in the same way, from large they become small. Moreover, those that grow suddenly are of very short duration, and are sometimes dissolved very quickly; those, however, that grow large gradually persist longer.

[Margin: Cometarum nuclei creſcunt, & decreſcunt.] *The nuclei of comets grow and decrease.*

10. The nuclei of comets, that is, their denser parts together with the rarer, mostly arise from shadows, that is, from the most dilute exhalations and vapours of the planets, and from certain very small particles. Then they gradually coalesce out of many, so that not rarely a single nucleus is born from many separate nuclei; and in turn, sometimes two, three or more are born from one.

11. Just as comets very rarely consist of one single nucleus, so the [nucleus] larger than the rest rarely stands exactly in the middle of its body; rather, it mostly turns aside from time to time towards the sides, drawing a thinner mass along with it.

[Margin: An præcipuus nucleus ſemper in medio capitis conſiſtat.] *Whether the principal nucleus always stands in the middle of the head.*

12. The nuclei, like the rarer parts, grow and become brighter through the inflow of matter and through condensation; in turn, through the outflow of matter and through rarefaction they become paler, whiten and grow dull.

[Margin: Nuclei, alii aliis ſunt ſplendidiores & ſolidiores.] *Nuclei: some are brighter and more solid than others.*

13. Every comet, like a spot of the Sun, is clothed round with a certain other body, less obscure and rarer, as with an atmosphere of its own, in which the rays of the Sun are stopped, so that the tail may be produced, as will be clearer from what is to be said below.

[Margin: Nuclei cinguntur rariori quâdam materiâ.] *The nuclei are girded by a certain rarer matter.*

14. Nor is it contrary to reason that the rarer parts of comets are produced before the nuclei; just as, in my opinion, no comet perishes whose nuclei do not first fail gradually, so that the more solid and denser parts undergo dissolution sooner than the thinner ones.

[Margin: Solidiores partes ante totalem diſparitionem diſſolvuntur.] *The more solid parts are dissolved before the total disappearance.*

15. The nuclei of comets, like those of the spots, are neither generated nor corrupted always in the same place of the heaven, but anywhere, without distinction.

[Margin: Per totũ ætherem datur generatio & corruptioCometar.] *There is generation and corruption of comets throughout the whole aether.*

16. Some, moreover, are longer-lasting than others, by reason of a fatter (if one may speak so) and denser matter. Some, again, are born around the beginning, some around the middle, and some, finally, around the end; and in the same way they also perish. Sometimes the same nucleus endures from its first rising until its destruction, now growing, now decreasing. In this, however, comets and their nuclei differ entirely from the spots: the same comet never comes back in its orbit by reason of its proper motion, or becomes a returning one, and so ascends our horizon a second time, that is, rises astronomically; the diurnal motion is excepted, which is not considered here. For once a comet is extinguished, it can by no means happen that it comes forth again, much less that it lasts on.

[Margin: Nullus Cometa fit unquam redux,ut quidem Maculæ.] *No comet ever returns, as the spots indeed do.*

17. Not rarely two, indeed several, comets appear that are at first almost equal in appearance, both as to density and as to size; yet they do not perish together, but at different times and places. I would have this understood of their nuclei as well.

[Margin: Cometæ ſimul exorientes, non ſimul intereũt.] *Comets that rise together do not perish together.*

18. Every comet, just like a spot, consists of opaque, dense matter, dark in itself, drawing all its light wholly from the Sun.

[Margin: Cometæ lumen à Sole mutuantur.] *Comets borrow their light from the Sun.*

19. Comets are larger than they appear, whether their apparent diameter is smaller or larger than the apparent diameter of the Sun, the body, namely, that illuminates them; for the reasons brought forward in Book VI, page 334.

[Margin: Sunt majores quàm apparent.] *They are larger than they appear.*

20. No comet, either as a whole or in its parts or nuclei, turns about an axis; rather, it always turns the same face towards the Earth and the Sun, except that it is moved with a libratory or reciprocating motion, not equal in all comets but according to their greater or lesser distance from the Earth, as will become clear from what has been said before and what is to be said below.

[Margin: Cometa quidem in axe non circumvolvitur; ſed motui tamen libratorio eſt obnoxius.] *A comet indeed does not revolve about an axis, but it is nevertheless subject to a libratory motion.*

Aphorisms 21 and 22 of the solar spots are deferred to Book IX, where we shall deal expressly with the proper motion of comets as a whole.

23. The nuclei of comets likewise, like those of the spots, have a motion of their own relative to one another, though one that is always irregular and anomalous. Hence those corpuscles and nuclei of which the whole comet is composed move in various ways with respect to one another: they approach, recede, join together and separate, leaving aside that proper motion which the comet performs in its orbit as a whole. And from this proceed the sudden coalitions of the nuclei, their abrupt digressions, their disordered deviations, and the perpetual transformations of the figures.

[Margin: Nuclei peculiarem exercent motum anomalum.] *The nuclei perform an anomalous motion of their own.*

24. Although comets sometimes exceed the Moon and the Earth in diameter and disc, or in the area of a great circle, they nevertheless do not exhaust the planets, nor do those bodies suffer any decrease at all from this; just as not even the least amount is lost to the Sun through the generation of the spots. For every celestial body, when the matter has been dissolved and attenuated, calls back and draws in again what is its own.

[Margin: Generatio Cometarum n[[ò/o]]n officit Planetis.] *The generation of comets does no harm to the planets.*

25. Comets are never equidistant, either from the Sun or from the Earth; rather, some are more remote than others, so that sometimes they undergo a sensible parallax, and sometimes none at all, as is always the case with the spots.

[Margin: Cometa alius alio eſt remotior.] *One comet is more remote than another.*

26. Just as the Sun [produces] primary spots not perpetually but only at certain times, so the aether too produces comets, and indeed very rarely,

inasmuch as the matter is lacking. For that thinner matter, which sometimes migrates even beyond the atmospheres, is not present, so far as can be gathered, in as great an abundance as the somewhat thicker matter from which the spots of the Sun and the secondary comets, which we discussed on page 428, are generated. Moreover, since this denser matter remains perpetually in the atmosphere, it more easily flies together, as in a far narrower space, joins together and clings to itself, so that a spot can be produced within a short interval of time. But those thinner expirations, because they are pushed out this way and that into the vastest aether, into the most diverse parts of the heaven, and are dispersed, do not meet so easily; and they do not come together and aggregate except by some chance. In addition, as we have said, they are much less frequent; so it is no wonder that comets are rare spectacles of the heaven.

[Margin: Cometæ cur ſint rariſſima Cœli phænomena.] *Why comets are the rarest phenomena of the heaven.*

End of Book VII [FINIS LIBRI VII.]

Johannes Hevelius, Cometography, Book Eight [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER OCTAVUS.]

On the Tails of Comets [De Cometarum Caudis.]

I think it must be ascribed wholly to the Aristotelian doctrine that the business of comets in particular has until now been overspread with such thick darkness. Indeed, had this dogma not besieged and bewitched the minds of very many of the ancient philosophers, they would not merely have cultivated it by inheritance; rather, they would long ago have turned their minds and eyes anxiously to these phenomena, holding nothing [?] more important than how this study might at last be propped up with more solid reasons.

[Margin: Niſi Peripateticorum Schola obſtitisſet,equidem plùs ultra, in ſpeculationibusCometarum jam pervenisſemus.] *Had the school of the Peripatetics not stood in the way, we would indeed have advanced further by now in speculations about comets.*

But since they acquiesced entirely in certain Aristotelian pronouncements, and cast comets out among purely meteorological things, they abstained from them altogether, as from rather trifling and sublunary matters in their judgement, devoting themselves instead to speculations about more sublime things. Hence, I think, it came about that the Babylonians, the Egyptians and the Greeks as well recorded so very few hairy stars, let alone described them accurately; so that it is now difficult to dig out anything at all of the greatest truth about them, especially since the more recent [writers] too have barely touched upon this very subject of the tails of comets. Yet this will not deter us, nor make us abandon this business at once; rather, we judge that we must press on all the more eagerly with what we have begun. For the less worked out each thing is, even if it is difficult and abstruse, the greater the effort and industry

with which it must be carried through; and everything that seems to have been neglected until now must be made good by untiring study.

[Margin: Quare Veteres, Cometas neglexerint ?] *Why did the ancients neglect comets?*

Antonius Myzaldus rightly agrees with us, in Book I, Chap. 17, page 99: "Certainly," he says, "our care today must be far more diligent, both in these matters and in almost all others (which, namely, were either wholly neglected by antiquity or handled with very little care [?]). Let us therefore strive wholeheartedly to leave the heaven and the natures of things, a door happily opened by divine [?] favour [?], more open to our descendants; and, having laid aside [?] the accursed hunger for gold, let us resolve henceforth to enrich the arts with our additions and to make them an inheritance for posterity [?]." If these things were fixed somewhat more deeply [?] in the minds of all, they would indeed be brought to light without great labour.

[Margin: Quò minùs quid detectum, eò magis allaborandum quò detegatur.] *The less something has been uncovered, the more one must labour to uncover it.*

But there is no reason for you to think that I have proposed to bring this doctrine of comets to absolute [?] perfection; far from it! But I shall at least labour,

[Margin: Quidnam de Autoris labore Cometographico ſperandum.] *What is to be hoped for from the author's cometographic labour.*

so that the matter may be set, within my small capacity, somewhat more clearly before everyone's eyes, and so that a way may gradually be laid for arriving at last, in the course of time, at the truth itself. And so that all of this may be carried through the more successfully, it will be worthwhile to show how many kinds of comets' tails there are, and also to present in outline their most diverse differences, both those that were observed long ago and those that may perhaps occur. Since, however, the differences of the tails depend chiefly on the most diverse forms of the heads, it will be necessary, now that the occasion offers, to set out beforehand some things about the various appearances and kinds of comets (which it has not been possible to do until now), so that we may follow everything through in this order.

First, then, it is abundantly clear from the histories and from the writings of learned men that the species of comets have been manifold, indeed so multiform that hardly ever has one comet been wholly equal to another, whether in figure, in size or in colour. Seneca agrees, *Natural Questions* Book VII, Chap. 20: "We see," he says, "various kinds of fires conceived on high: now the heaven burns, now

long trails of flames grow white behind,

now torches are swept along with vast fire." Likewise a little later: "In this class belong those wonders written of by Posidonius, blazing columns and shields, and other flames of remarkable novelty." Similarly in Chap. 21: "Our own [school] too holds that comets, like torches, like trumpets and beams and other portents of the heaven, are created from dense air."

[Margin: Quotuplices ſintCometarum Caudæ, faciesque.] *How many kinds of comets' tails and appearances there are.*

In Pliny, however, Book II, Chap. 25 and 26, there are ten species of comets: namely *Pogoniæ*, *Acontiæ*, *Xiphiæ*, *Discei*, *Pithei*, *Ceratiæ*, *Lampadiæ*, *Hippei*, *Argirocomi* and *Hirci*. From these it is certain that comets have been of many kinds, and that the ancients distinguished them both by the various appearances and forms of their heads and by those of their tails.

[Margin: Plinii diſtinctio Cometarum.] *Pliny's classification of comets.*

The more ancient of the astronomers, however — namely the Assyrians, the Egyptians, the Arabs, the Carthaginians, the Saracens and the Moors, as Antonius Myzaldus reports on comets in Book I, drawing indeed on the most ancient foreign and barbarian writers on celestial things — were accustomed to distinguish comets according to their different colours, and indeed those of the planets: that is, into Saturnian, Jovian, Martian, Solar, Venusian, Mercurial and Lunar comets.

[Margin: Antiquiſſimi Autores, ex coloribus Cometas diſtinxerunt.] *The most ancient authors distinguished comets by their colours.*

The Saturnian is of a dusky and leaden colour; it gives out a dark, blackish flame and displays a somewhat livid hair. The Punic and Saracen astronomers call it "the black one", as the same author attests in Book II, Chap. 2.

[Margin: Cometa Saturninus.] *The Saturnian comet.*

The Jovian is marked by a whiteness tinged somewhat with purple; the ancients named it the Column and the Tenaculum.

[Margin: Cometa Jovialis.] *The Jovian comet.*

The Martian is ruddy and wholly fiery; the Moorish astronomers call it the Lance, the Pole, or the Spit.

[Margin: Cometa Martialis.] *The Martian comet.*

The Solar comet, as the Assyrians hold, scatters fires round about and displays a golden colour. From its remarkable light it is called the Rose, and it has sometimes been seen to show a human face with a short tail, and to display a flame as if purple or golden.

[Margin: CometaSolaris.] *The Solar comet.*

The Venusian is silvery and whitish, and was named by the ancients the Dawn, or the Morning Star. They say that one of this kind appeared which blazed for some time a little before Cosdras, King of the Persians, plundered Jerusalem.

[Margin: CometaVenereus.] *The Venusian comet.*

The Mercurial, somewhat blue, or rather of changing colour, having an oblong tail and a wandering hair, is called *Dominus Asconæ* by the Saracen astronomers. That such a comet existed is held by the same named

[Margin: Cometa Mercurialis.] *The Mercurial comet.*

author, in the year 1260, in the eastern region of the heaven, and that for almost six months it spread its hair far and wide from its rising up to the middle of the heaven, and bore the type of the Mercurial. The Lunar, again, is marked

by a whiteness and brightness just like the Moon's, and pours its hair out backwards; the Arab astronomers call it the Soldier. "That one of this kind blazed forth in the region of Italy around the year 1515, more or less, while the Florentine Leo reigned as pontiff, several books have assured me," says Myzaldus, Book II.

[Margin: Cometa Lunaris.] *The Lunar comet.*

Indeed, it certainly cannot be denied that comets have been of quite dissimilar colours, as was shown at length in the preceding Book, and that they can therefore be distinguished to some extent on the basis of colour. In our judgement, however, they are distinguished more fittingly and more accurately by the appearance and form both of the head and of the tail. For very many kinds of comets occur, whereas there are only seven species of colours, corresponding to the planets. If, then, comets are considered according to their various appearances, none comes our way that is not defined exactly in that manner [?].

[Margin: Cometæ,meliùs ex facie, formâq; diſcernuntur.] *Comets are better distinguished by their appearance and form.*

All of them, however, to put the matter briefly, are referred to two classes: namely, the hairy or long-haired, and the [Greek: Πωγωνίας (pōgōnias, "bearded")], that is, the bearded or tailed. The former spread their hair all round, and so they are also called hairy; the latter stretch out their hair either along their breadth or along their length. Some, it is true, distinguish the bearded from the tailed, but wrongly. For there is no difference between the two, except that at one time they extend their train upwards, at another downwards. So when they show their hair downwards they can, if one likes, be called bearded; but when they raise their tails upwards, or trail them behind, they can in a way be named tailed. Since this distinction is nevertheless not a real one, it must be rejected altogether.

[Margin: Cometæ alii ſuntCriniti,alii Barbati.] *Some comets are hairy, others bearded.*

Under the two genera just named, therefore, are comprised the various species of comets, about twelve in number; some of these must in turn be subdivided, as you will soon learn at greater length. To the class of the long-haired, or hairy, belong the [Greek: δίσκεος (diskeos, "disc")], the [Greek: πιθίτης (pithitēs, "jar")], the [Greek: ἱππεὺς (hippeus, "horseman")], the [Greek: ἀργυροκόμης (argyrokomēs, "silver-haired")] and the *Hircus*. To the order of the tailed are referred the [Greek: λαμπαδίας (lampadias, "torch")] (which some count among the bearded), the [Greek: κερατίας (keratias, "horned")], the [Greek: ἀκοντίας (akontias, "javelin")], the [Greek: ζιφίας (ziphias, as printed; "sword")], the [Greek: λογκίτης (lonkitēs, as printed; "lance")], the Spit or Pole, and the [Greek: τετραγωνία (tetragōnia, "square")]. But so that these most diverse comets may become known the more accurately to each and every [reader], we have decided to describe them somewhat more fully as

to their figure and appearance, not neglecting their colours, and at the same time to append here their subordinate species, if any are found.

[Margin: Vera Cometarum diſtinctio.] *The true classification of comets.*

1. The Disceus is a disc-shaped comet, which is either entirely round or imitates a nearly round figure. Chief among these is the Solar, called the Rose or *Chryseus*; it usually appears most brilliant and of a silver colour, as if mixed with gold, or of the colour of electrum, and it is surrounded by very sparse hair, as Kepler holds in Chap. 25, on the new star of Serpent. To this class he also refers the nocturnal Suns celebrated by the more ancient [writers]. Those, however, that do not show a perfect roundness all express roughly the figure of a shield; they are, however, of different kinds, as will soon be clear.

[Margin: CometaDiſceus.] *The Disceus comet.*

2. The Pitheus, or cask-shaped comet, presents the likeness of a cask; it too has various species, as will have to be said more fully in its place.

[Margin: Pitheus.] *The Pitheus.*

3. The Equinus, or Hippeus, resembles a horse's mane; it is curved and broadly spread out, although it does not always display the same figure.

[Margin: Equinus.] *The Equinus.*

4. The Argyrocomus, or silver-haired comet, is not very unlike the Solar, except that it is white, and so resplendent with silvery hair that one can hardly look at it, as Pliny attests.

[Margin: Argyrocomus.] *The Argyrocomus.*

5. The *Hircus* is surrounded by the appearance of shaggy tufts and by a kind of mane, and bristles with very fine fibres of rays; it is likewise seen as round, and without a tail.

[Margin: Hircus.] *The Hircus.*

6. The Lampadiformis, which has as it were the figure of a lamp, or which imitates burning torches, is observed under quite different appearances. For some carry a sharpened point upwards; others even shoot out, as it were, two, indeed three, points. Phenomena of this kind, however, are of the rarest appearance: for we find scarcely a single one properly recorded from antiquity.

[Margin: Lampadiformis.] *The Lampadiformis.*

7. The Ceratia, or Cornutus, also called by another name corniformis, appears sometimes without any beard or hair, sometimes tailed. The former shows a head like the phase of a curved, or crescent, Moon; the latter has a curved tail, bending now upwards, now downwards. Of these, likewise, some show a tail almost equally dense and broad on every side; others display pointed hair, having the look of a horn, or the figure of a trumpet, or of a comb.

[Margin: Ceratia.] *The Ceratia.*

8. The Acontiæ quiver in a long series of rays in the manner of a javelin, and have the form of a javelin; they generally have a rather compressed and oblong head, and also a long and very thin tail.

[Margin: Acontiæ.] *The Acontiæ.*

9. The Xiphia, or Ensiformis, sometimes bears the appearance of a rhomphaea, or sword; it presents a head like a hilt, and a tail usually straight and tapering to a point. Moreover, it shines greatly in colour and light, although some of these also present themselves to view with curved tails in the manner of a scimitar. Not, however, at all times with the same constant appearance. For some, smaller as to head and hair, shine like a dagger or a fiery sword; others, finally, are very pale, and display the gleam of a sword without any distinct rays; and very many of them indeed occur here and there in the histories.

[Margin: Xiphia.] *The Xiphia.*

10. The Longitis, or spear-shaped comets, which have the figure of a lance or spear, are endowed with an elliptical head but a pointed, long and very thin tail; they are also not infrequent.

[Margin: Longitis.] *The Longitis.*

11. The Spit, or Pole, comes close in appearance to the spear-shaped, except that it is somewhat rounder in the head, and still longer and sharper in the tail; these, however, are also widely unlike one another.

[Margin: Veru, ſeu Pertic[[a/æ]].] *The Spit, or Pole.*

12. The Quadratus presents an angular head, indeed usually a quadrangular one, and moreover a very long, very dense and uniform tail; in other respects it is not unlike a fiery beam. They report that one such appeared in the year 372 or 373 before the birth of Christ.

[Margin: Quadratus.] *The Quadratus.*

And these are the chief of all those that have ever been recorded by writers, although there are many further species of the tailed, which are usually the more frequent. For now a beard let down long, now a more compressed one, now one blunter at the top, now one narrower at the end; now, in its drawing-out, one thin-

[Margin: Cometæ, ratione barbæ, valdè etiam inter ſe differunt.] *Comets also differ greatly among themselves in respect of the beard.*

ner, now one more dispersed where it ends, like that of the [comet] that appeared in the year 1618, they present; now, at the head, at the beginning, a very broad and very dense tail, now, at the end, a very sharp and very diluted one, as happened in the comet of the year 1652, they show. Moreover, they stretch out their hair now straighter, now more oblique, now bending upwards, now downwards; some have a continuous train, others a divided and separated one, some a permanent one, others a changeable one; so that the images of comets are most diverse: almost every single one usually presents a singular appearance, so that they can hardly be described so briefly.

To do all the more justice to this matter, then, and so that these most diverse species of hairy stars may be shown the more clearly, we have worked diligently, as far as was permitted and as far as we could gather from the histories, so that both the genuine appearances of earlier comets and the true likenesses of certain more recent ones, as regards head and tail, might be set before the eye accurately and graphically in certain small plates. But I would have you note that we have not observed the true proportion either of the head or of the tail so strictly in each comet, but only so far as the paper allowed. Nor indeed does it matter much, since you will learn the genuine proportion abundantly enough from the histories and from our Chronological Table of Comets; it will therefore be enough here to have expressed the figure and form correctly and duly.

[Margin: Quò rerum arcanarum Scrutatoribus magis ſatisfiat, Autor plurimorumCometarum effigies ſub genuinâ ſpecie delineavit.] *To give the investigators of hidden things more satisfaction, the author has drawn the likenesses of a great many comets in their genuine appearance.*

As for the heads of all the comets, however, [we drew them] not as if they had been observed with the naked eye, where we detect nothing at all beyond some brightness and the figure of the face; rather, we delineated them as if they had been examined accurately with telescopes, according to their nuclei and the most diverse density and rarity of their matter. Accordingly we have portrayed all the appearances of comets, in keeping with our hypothesis, in exactly the manner in which we judged, to our mind, they had approximately been. Approximately only, I say: for since they were not examined with the telescope, it could by no means be done so exquisitely. I readily grant, indeed, that some comets perhaps consisted of larger, denser nuclei and bodies, now more numerous, now fewer; others again of smaller and rarer ones, of a quite different form or figure. This, however, makes no difference, provided we sketch these various appearances of comets in such a way that it is clear to everyone that the figures consist of nuclei of every kind, and that the tails can thus, in their proper place, be derived from them the better. Above all, however, we took pains that, in constructing and forming the nuclei and bodies, the colour, brightness and darkness of the comets, and their whole genuine aspect, should be expressed in the best ways. The paler and somewhat dark comets I built from smaller, more diluted and rarer nuclei; the more splendid and fiery ones, by contrast, I composed of larger and more solid bodies, that is, darker ones, and also of denser tails, just as our hypothesis seems to require for this business. So that at the very first glance no one will fail to understand and clearly judge which comet was redder or paler, darker or brighter. All of which, believe me, will be of the greatest help to this study of the tails of comets, which we have now undertaken, under the auspices of God, Best and Greatest, to set out and demonstrate the more accurately.

[Margin: Capita Cometarum, quâ ratione ab Autore depicta fuerint.] *How the heads of comets have been depicted by the author.*

[Margin: Quâ ratione Cometarum diverſa claritas, & obſcuritas expreſſa fuerit.] *How the different brightness and darkness of comets has been expressed.*

In the first Figure, then, of the accompanying figure [Iconiſmi] G, we have given a drawing of the Solar comet, or Rose, or *Chrysium*. As we have said, it appears entirely round in its face, most brilliant in light, of a fiery or ruddy colour, and scattering golden rays, as it were, all round. A comet of this kind shone upon the world in the year 146 before the birth of Christ; Seneca [speaks] of it in Book VII, Chap. 15, of the *Natural Questions*: *After the death of Demetrius, King of Syria, whose children were Demetrius and Antiochus, a little before the Achaean war, a comet shone forth no smaller than the Sun. At first it was a fiery and ruddy disc, giving out a bright light, enough to overcome the night. Then its size gradually contracted, and its brightness vanished. At last it disappeared entirely.*

[Margin: Quando Cometa Solaris apparuerit.] *When the Solar comet appeared.*

Under numbers 2, 3 and 4 we have painted various shield-shaped [comets] belonging to the order of the disc-shaped [diſceorum]: they imitate the form of a shield, and usually also shine with very splendid and fiery rays. Pliny is the authority, in Book II, Chap. 25, that such a burning and blazing shield appeared in the consulship of L. Valerius and C. Marius; and Seneca, in Book VII of the *Natural Questions*, Chap. 20, attests that others were observed by Posidonius.

[Margin: Quo tempore Cometa clypeiformis extiterit.] *At what time the shield-shaped comet appeared.*

Images 5, 6 and 7 present the Pithei, which Pliny also mentions in the same chapter cited. They are oblong in appearance: for he says that they are seen in the figure of casks, and that, as if in a hollow, they hide a smoky light and dark rays in their middle. These, however, are of different kinds: one, namely, is oval in figure, another cask-shaped and upright; another cask-shaped, inclined and truncated; another, likewise cask-shaped, appears tailed, that is, endowed with some hair.

[Margin: Quâ facie ſint Pithei.] *What appearance the Pithei have.*

Under nos. 8, 9 and 10 you see three Equini, in the form in which, together with Cornelius Gemma and Aldrowandus, we judge them altogether to have existed. They scatter wandering and shaggy hair in the likeness of manes; yet not all of them are seen in the same manner, nor in the same form. Sometimes they are oblong, spreading their train sometimes in front, sometimes behind; sometimes they imitate an oval figure, sometimes a rhomboid. I therefore distinguish them into the bearded Equinus, the angular or quadrangular Equinus, and the elliptical Equinus. Pliny has this to say of them: *The Hippeus: horses' manes, of very swift motion, and going round in a circle about themselves.*

[Margin: Cometæ Equini ſunt quadruplices.] *The Equine comets are fourfold.*

In Figure 11, 12 and 13 the Lampadiae are shown, which imitate burning torches, like a lamp or a small burning torch. Such was the comet that appeared in the consulship of Cn. Octavius and C. Scribonius, and was seen by the proconsul Licinius Syllanus with his retinue, as Fortunio Liceti gathered from

Pliny in Book II, Chap. V. These, however, I refer to three classes, whose different likenesses may be seen here.

[Margin: Lampadiformes in tres referuntur claſſes.] *The Lampadiformes are referred to three classes.*

There follows, under number 14, a star haired on every side, or ringed [circinnata], otherwise called the *Hircus*; not a few of these are found in the records of the ancients. One such appeared in the year 44 before the birth of Christ, after the murder of Caesar, as Suetonius attests in the *Julius Caesar*, Chap. 88: *He died*, he says, *in his fifty-sixth year, and was enrolled among the gods, not only by the mouth of those who decreed it but also by the conviction of the common people. For at the games which his heir Augustus was giving, consecrated to him for the first time, a hairy star shone for seven days in succession, rising about the eleventh hour, and it was believed to be the soul of Caesar received into heaven; and for this reason a star is added on the top of his statue*: so he [writes]. Plutarch also [speaks] of it in the *Life of Caesar*, and adds that it was a huge hairy star. And Pliny too, Book II, Chap. 25:

[Margin: Hircus quo tempore apparuerit.] *When the Hircus appeared.*

Diagram. Full-page engraved plate, "Fig. G.", showing sixteen kinds of comet head, numbered 1 to 16, in five rows. Each of the first four rows is headed by a caption naming a class of comets, and each head carries its own label and number. Row 1 (1–4): a round head ringed by curved, flame-like rays; a round head with short spiky rays and two tufts of hair hanging below it; a roughly round head ringed by pointed rays; an irregular head fringed with fine hair. Row 2 (5–7): an upright oval head fringed with hair; a horizontal oval head fringed with hair; an oval head with a long tail streaming to the right. Row 3 (8–10): elongated heads with hair drawn out to either side. Row 4 (11–13): round heads with plumes of hair rising above them. Row 5 (14–16): a head wrapped all round in curled hair; a head inside a disc of horizontal hatching; a head ringed with short rays, with hair hanging below. "Fig. G." stands at lower left and the engraver's line at lower right. All labels on the plate are listed below; none is supplied from the text.

- Row 1, caption: "Cometæ Diſcei ſeu Ceriſei." *Discei or Cerisei comets.*
- 1: "Solaris ſive Roſa." *The Solar, or the Rose.*
- 2: "Diſciformis." *Disc-shaped.*
- 3: "Clypeiformis." *Shield-shaped.*
- 4: "Clijpeus ardens." *Burning shield.*
- Row 2, caption: *Cometæ Pi[?]ei. Pi[?]ei comets.*
- 5: "Doliiformis erectus." *Cask-shaped, upright.*
- 6: "Doliiformis truncatus." *Cask-shaped, truncated.*
- 7: "Doliiformis caudatus." *Cask-shaped, tailed.*
- Row 3, caption: "Hippei ſive Equini." *Hippei or Equini.*
- 8: "Equinus barbatus." *Bearded Equinus.*
- 9: "Equinus quadrangularis." *Quadrangular Equinus.*
- 10: "Equinus Ellipticus." *Elliptical Equinus.*

- Row 4, caption: "Lampadiæ." *Lampadiae.*
- 11, 12 and 13: each "Lampadiformis." *Lamp-shaped.*
- 14: "Hircus." *Hircus.*
- 15: "Fuſcâ nube circundatus." *Surrounded by a dark cloud.*
- 16: "Barbatus." *Bearded.*
- Lower left: "Fig. G."
- Lower right, inside the plate mark: "Autor ſculps." *Engraved by the author.*

in the very days of my games (these are the words of Augustus) *a hairy star was seen for seven days in the region of the sky that lies beneath the Septentriones. It rose at about the eleventh hour of the day, and was bright and conspicuous in all lands.* A hairy star of the same kind shone in the year of Christ 673, on the authority of Lavatherus: *A hairy star*, he says, *which the Greeks call a comet, appeared for three months.* Palmerius, however, assigns it to the year 675. Likewise, in the year of Christ 1506, on April 3, a haired star of this kind appeared within the Bear [inter Arcton] for 25 days, as Prætorius, Cardano, Suessanus and Lavath. report.

[Margin: Cometa tempore Auguſti Cæſ.] *The comet in the time of Augustus Caesar.*

The comet of the year 1580 observed by Mästlin can also be counted among the *Hirci*, at the start, when it was coming into view: for it appeared entirely without a tail, with a round head, shaggy on every side. The said author noted the following about it: *On October 2, the day on which it was first seen by me, it lacked any tail at all, having a circular figure surrounded all round with hair. It exceeded Venus in size, but in the brightness of its light it could by no means be compared [with her]. For it shone with a very dull and dark, or blackish, colour, not unlike a dark and nebulous star.* Chap. II, p. 13, in the *Observation* of the same comet.

In image 15 is shown a comet surrounded by a dark cloud, or covered with a thin cloud, such as the one observed in the year 459 after the birth of Christ. Of it Lavath. noted the following in his Catalogue of Comets: *In the times of Chilperic, King of the Franks (he began to reign in the year 459), a comet was seen carried round [circunlatus] by a dark cloud, shining with its ray.* Robertus Sanguinus, Book II. Likewise in the year 684, [a comet] which was like the Moon showing through a thin little cloud.

[Margin: Cometa fuſcâ nube circundatus.] *A comet surrounded by a dark cloud.*

Image 16 expresses the face of a bearded comet, which namely displays a rather short tail on one side. Comets of this kind are indeed not only found in very great numbers; even the greatest part of tailed comets, although at first they stretch out a long coma, nevertheless in the course of time sometimes compress it, so that at times they put out only a short beard, as will be said at greater length in its place. Of those, however, that were observed with a cut-short beard right at their first appearance, there were, to say nothing of others, three in particular. Namely, in the year of Christ 1521, as Riccioli noted in Book VIII, Sect. I of the *Almagestum*: *A comet was conspicuous* (he says) *in*

the month of April at the end of Cancer, having short hair, bright, and like the Moon at dichotomy. Next, in the year 1556, a second was detected with almost the same face, as Cardano attests in Book 14, chap. 69, of *De Varietate*: for he says, *about the beginning of March it shone forth, almost equal to half the Moon, with hair that was not long.* Moreover, a similar comet appeared in the year 1585, which was observed by Tycho and Rothmann; he wrote the following about it to the Landgrave, p. 13: *In the year that was 1585 from the birth of Christ, on October 18, Old Style, I unexpectedly noticed a certain adventitious star, endowed with a dark, rare and nebulous light, near the cord of the more southern Fish, which in its whole form was as like as possible to the nebulous ring that they call the Manger of Cancer, except that from the beginning, around this day and some following days, it appeared somewhat larger than this very ring; so much so that, if one looked more carefully at its very extremities, it would very nearly equal the star of Jupiter in apparent size, although, because of the gloomy appearance of its dull light, it by no means presented itself to the eyes as distinctly as the planets, or the fixed stars, coeval with the world. It was, however, in the middle part of its body, of a more compact*

[Margin: Cometa Barbatus.] *A bearded comet.*

[Margin: Caudam quandoq́; comprimuntCometæ.] *Comets sometimes compress their tail.*

[Margin: Cometa Lunæ dichot[[o/ò]]mæ ſimilis.] *A comet like the Moon at dichotomy.*

[Margin: Anno 1585 Cometa barbatus fulſit.] *In the year 1585 a bearded comet shone.*

light, but towards the extremities rarer and more dispersed. On all sides, too, it was quite round, and it stretched out no tail or beard toward one side more than another, except that on the 20th and 22nd, to those gazing very sharply and for a long time, a certain slight trace of some very delicate little ray, scarcely a span in length, was thought to extend toward the west, as far as could be seen. Nor was it possible to perceive anything of the kind in it at any other time, throughout its whole duration. It diminished gradually, however, so that about November 4 it was a little smaller than the already mentioned nebulous ring of Cancer, with which it still agreed exceedingly well in colour and form; then, becoming gradually smaller still, it disappeared completely about the middle of November. From this it is clear that at the beginning this comet came closer to the preceding fifteenth drawing, but towards the end displayed a beard a span long; so that it could, not inaptly, be expressed by the sixteenth image.

[Margin: Cometa absq́; barba apparuit.] *A comet appeared without a beard.*

In the accompanying figure [Iconiſmo] H there follow the faces of the Ceratiae, or Horned [comets]. Under number 17 a Horned [comet] is seen, which, for the sake of distinction, it pleases [me] to call the Horn-shaped Crescent [Corniformem Lunatum], since it is not very unlike the crescent phase drawn in the *Selenographia*. They judge that such a one appeared in the first year of the 75th Olympiad, that is, in the year 480 before Christ, when Xerxes crossed into Greece and Greece fought the battle out at Salamis, as Pliny

reports, Book II, Chap. 25. But I am of the opinion that it was rather like the following figure, 18, so that it displayed a curved and pointed tail. Of these, without any doubt, there have been several, directing their point now upward, now downward, had they only been duly recorded by antiquity. I would venture to say that very many of this class were once taken for sword-shaped [comets]. But however that may be, the comets sketched under number 17 ought not, on that account, to be counted among absurd things, as if Ceratiae had neither appeared at some time with exactly that face, nor could appear so in the course of time. For in our judgement it can happen that they sometimes shine forth in such a form: this we learn clearly from the solar spots. For it is most thoroughly established that not a few of them have a crescent figure of almost this kind: of this kind were spot *k*, in the year 1625, on June 15, and likewise spot *b*, on the 28th of the same month, which were detected by Scheiner and are available to everyone in his *Rosa Ursina*.

[Margin: Species Cornutorum.] *Species of Horned comets.*

[Margin: Longè diversâ nonnunquam facie Cometæ apparent.] *Comets sometimes appear with a very different face.*

Besides these species of Horned comets, however, still other comets are found whose tails run out into two points. Such, unless I am mistaken, was the one that Benedictus Accoltus [Benedetto Accolti] mentions in Book 16 of the war waged in Judaea by the Christians [de bello Judaico à Chriſtianis geſto]: for he states that at that time a horned comet was seen in the sky, with fiery and great horns. This, indeed, is to be understood only of the coma, for the head could in no way have displayed such great horns. We have therefore drawn such a one under number 19.

[Margin: Cometa cornibus igneis & grandibus obſervatus.] *A comet observed with fiery and great horns.*

Of this kind, as I think, there can be still other, different ones, which present a tail similar indeed, horned, but at the same time bent, and also more spread apart around its extremity, not unlike an ostrich's feather, as Figure 20 shows. To these also the comet of the year 1618 seems to belong: not, indeed, that greatest one and chief of the rest (for four appeared in that year), which from the month of November up to January of the following year itself to be seen

[Margin: Cometa inſtar pennæ Struthionis.] *A comet like an ostrich's feather.*

Diagram. Full-page engraved plate, "Fig. H.", showing eight comets, numbered 17 to 24, set one above another, each with its head at the right and its tail streaming to the left. A caption near the top heads the first four (17–20); a second caption heads the last three (22–24). 17: a crescent-shaped head fringed with hair, its horns pointing to the left, at the far left of the plate. 18: a round head ringed with scalloped curls, with a long, narrow tail curving up to the left. 19: a round head ringed with crossed hatching, with a broad tail divided along its length into two branches. 20: a round head with spiky rays, with a broad, curved tail fanning out into separate plumes. 21: a round head fringed with hair, with a very broad tail of long, wavy streaks. 22: a head shaped like

a rounded triangle, fringed with hair, with a narrow tail. 23: an oval head fringed with hair, with a long, narrow tail. 24: a round head fringed with short rays, with a long, narrow tail. "Fig. H." stands at lower left and the engraver's line at lower right. The left edge of the plate lies under the edge of the facing leaf in the photograph, which covers the opening letters of the label of comet 17. All labels on the plate are listed below; none is supplied from the text.

- Upper caption: "Ceratiæ ſeu Cometæ Cornuti." *Ceratiae, or Horned Comets.*
- 17: "[?]rniformis [?]unatus." *[?] (the opening letters of both words are covered by the facing leaf).*
- 18: "Corniformis." *Horn-shaped.*
- 19: "Cornutus bicuſpidatus." *Horned, two-pointed.*
- 20: "Curvatus Divaricatus." *Curved, spread apart.*
- 21: [?]ubiformis. *[?]-shaped.*
- Lower caption: "Acontiæ." *Acontiae.*
- 22: [?]aculi-formis Lunatus. *[?]-shaped, crescent.*
- 23: [?]aculi-formis Ellipticus. *[?]-shaped, elliptical.*
- 24: [?]aculi-formis rotundus. *[?]-shaped, round.*
- Lower left: "Fig. H."
- Lower right, inside the plate mark: "Autor ſculpſit." *Engraved by the author.*

showed; but that other one, which arose in the month of October and was observed in Silesia on November 10 at 4^{h} after midnight, as Kepler reports in the *Historia Comet.*, p. 51, whose coma is said to have been altogether like an ostrich's feather and at the same time curved: a kind of comet that, as the same author would have it, the ancients called a Ceratias [Ceratiam]. To these, moreover, are rightly added the comets of the year 1577 and of 1618, which was the most conspicuous of all and the last of that same year; although their images will be set before the eye individually below.

In image 21 a species of comet like a trumpet (otherwise called trumpet-shaped [tubiformis]) is shown. One of this kind blazed out in the year 348, of which Pliny, Book II, Chap. 25, says: *Once up to now the image of a trumpet has been changed into a spear, in the 108th Olympiad, in the 398th year of the City.* Exactly such a face was also presented by the one observed by Cornelius Gemma in the year 1569, as can be seen in the *Cosmocrit.*, Book II, Chap. 11.

[Margin: Cometa tubiformis.] *A trumpet-shaped comet.*

And these, roughly, are the images of the Horned [comets], so far as they have been handed down to memory by the ancients and by more recent [writers]. As for the Acontiae, however, or those that imitate the form of a javelin and dart with a long series of rays in the manner of a javelin: of these comets at least three kinds occur. For one is round as regards the head, another elliptical, another in some way crescent-shaped; but as regards the tail all are very much sharpened and pointed. This Javelin-shaped [comet] we have drawn under number 22, and indeed according to the idea of Cornelius Gemma. Pet. Surdus

reports from the Polish History [Hiſtoriâ Polonicâ] that a comet of exactly this kind, having the form of a javelin, appeared in the year 1472, in the month of March.

[Margin: Acontiæ, ſive Jaculi formam habentes.] *Acontiae, or those having the form of a javelin.*

Figure 23 shows another Javelin-shaped [comet], namely with an oblong head and a very large, very thin tail. Riccioli asserts, Book VIII, Sect. I of the *Almagestum*, that such a one appeared in the year 76 after the birth of Christ: namely, that it was Javelin-shaped, with a very long mane. Of these Pliny, Book II, Chap. 25: *The Acontiae*, he says, *dart like a javelin, with a very swift portent; this was the one about which the Emperor Titus Caesar wrote in a splendid poem in his fifth consulship, the most recently seen up to this day.*

[Margin: Alia facies Jaculiformis.] *Another face of the Javelin-shaped [comet].*

Image 24 expresses the third species of Acontias, or Javelin-shaped [comet], with a round head; such a one, as far as is gathered from the histories, was met with in the sky in the year 1513, on the authority of Petrus Surdus: *It was seen*, namely, *from the end of December up to February 19 of the following year, with various colours and an oblong tail, which ran out from the end of Cancer to the end of Virgo, and it was seen all night.*

In the following plate, I, you will now have the Xiphiae, kind reader: comets, that is, presenting the figure of a sword or blade. They are, however, of different kinds: some are fiery and shining; some are palish and turning leaden, and display the sheen of a sword without any distinct rays, as we touched on above. Such a Sword-shaped [comet], plainly showing the form of a sword, like a dagger or some smaller fiery sword, was observed in the year of Christ 632, before Persia was occupied by the Saracens, as Petrus Surdus and Spondanus relate from Theophanes. Funckius, however, from the *Annals of Constant.*, assigns it to the year 633. About it he further records this: a sign seen in the sky having the form of a sword, which stood toward the south for 30 days.

[Margin: Xiphiæ,facie inſtar gladii.] *Xiphiae, with a face like a sword.*

[Margin: Cometa inſtar pugionis.] *A comet like a dagger.*

The comets of the years 1526 and 1532 appeared with a face not entirely unlike [this]. Of the former, Pet. Surdus, part 2, records that it was like a fiery sword; the latter, however, Appianus observed. Of it Cardano, Book III *De Subtil.*, and Fracastoro, Book III *Homocent.*, Chap. 23, says [ait] that it rose on September 22 and set on December 3; moreover, that its head was three times larger than Jupiter, and that it had a coma two cubits long. Accordingly this phenomenon seems to come closer to the form of a dagger than of a sword. This face is shown by Figure 25 and 26.

[Margin: Cometa enſi igneo ſimilis.] *A comet like a fiery sword.*

In image 27 we set before the eye another species of the Sword-shaped [comets], like a great sword. That a comet of this kind hung over the city of Jerusalem for an entire year before it was destroyed by Titus, namely in the year 70 after the birth of Christ, is certain, on the testimony of an eyewitness,

Flavius Josephus, Book VI, Chap. 31. But I hesitate whether this phenomenon was brought forth according to the laws of nature: it seems rather to be held a miracle. But perhaps an occasion for discussing that matter will be given elsewhere. Meanwhile, however, other comets of the same kind have also been seen. For Prætorius testifies that under Theodosius, in the year of Christ 383, a comet like that one of Jerusalem shone, which, however, Riccioli refers to the year 392, Book VIII, Sect. I of the *Almagestum*. About it Nicephorus, in the *Ecclesiastical History*, Book 12, Chap. 37, has this: *During the reign of Theodosius, who began to reign in the year of the Lord 383, unusual prodigies were also seen, which foreshadowed evils to come upon the world. For first an unexpected and unaccustomed star appeared in the sky at dead of night, shining near the morning star, around the zodiacal circle. As for it, a huge and bright force of other stars too was gathered to its flashing rays. Had you seen this spectacle, you would have compared it to a swarm of bees flying round in a circle about their leader. And the light that flashed out from all of them, as if from a mutual and violent collision, mingled together and became one single flame. And, shining back with a certain terror, it presented the face of a sword altogether two-edged, great and dreadful. At first, in its whole bearing, it had been like a root, or as if some hilt appeared, and as if it put forth in some way all the brightness of that star displayed, just like the burning wick of a lamp, if they raised the flame on high. This sight, indeed, thus presented a certain new spectacle. But its motion differed altogether from the course of all the stars. For at first, beginning to move from the place we mentioned, it both rose and set together with the morning star. Then, gradually withdrawing from it, it held its course slowly and step by step, as if turned toward the Bears, and, as it were to those looking on [?], it advanced obliquely to the left on its own path. It completed, indeed, the same circuit in common with the other stars it had approached; but by its proper motion, which was prolonged to the fortieth day, it at last barely reached Ursa Major. And it vanished in the middle part of that constellation, where it had last shone. At that time this sword-bearing star, or rather one presenting the form of a sword, appeared.*

[Margin: Cometa Hieroſolymitanus, inſtar magni gladii.] *The comet of Jerusalem, like a great sword.*

[Margin: Notabilis Cometa tempore Theodoſii.] *A notable comet in the time of Theodosius.*

[Margin: Cometa inſtar gladii.] *A comet like a sword.*

From all of which it is clear that that phenomenon was a true and genuine comet, since it was not only in view for forty days, but also both rose and set every day together with the rest of the fixed stars, while constantly advancing toward the north by its proper motion. Moreover, by this haired star it is most evidently proved that comets are compounded of the most diverse corpuscles and nuclei; and hence it is not at all absurd that from di-

[Margin: An hic verus & genuinus fuerit Cometa ?] *Whether this was a true and genuine comet?*

[Margin: Ex diverſiſſimis nucleis extitit.] *It arose from the most diverse nuclei.*

Diagram. Full-page engraved plate, "Fig I", showing seven comets, numbered 25 to 31, set one above another, each with its head at the right and its tail streaming to the left. A caption near the top stands above the first. 25: a head of three rounded lobes, above, below and to the right, fringed with hair and marked with dark spots, with a long, narrow, straight tail. 26: a head like a sword's hilt, a cross-guard and a grip ending in a rounded pommel, fringed with hair and marked with dark spots, with a long, narrow, straight tail. 27: a larger hilt-shaped head, its cross-guard curving down at the lower end, its pommel a round spot with short rays, with a long, broad, straight tail drawn in feather-like strokes. 28: a hilt-shaped head with a long grip, with a long tail curving down to the left. 30: an oval head fringed with hair, with a long, straight, feathery tail, and a short point projecting to the right of the head. 29: a hilt-shaped head with a broad, rounded cross-guard and a long grip ending in a rounded pommel, with a long, broad, straight tail. 31: a round head drawn out into a sharp point to the right, like a spearhead, fringed with short rays, with a long, broad, wavy tail. The plate sets the number 30 above the number 29. "Fig I" stands at lower left and the engraver's line at lower right. All labels on the plate are listed below; none is supplied from the text.

- Caption: "Xiphiæ." *Xiphiae.*
- 25: "Enſiformis 1." *Sword-shaped 1.*
- 26: "Enſiformis 2." *Sword-shaped 2.*
- 27: "Enſiformis 3" *Sword-shaped 3*
- 28: "Enſiformis incurvatus." *Sword-shaped, curved.*
- Caption above the next comet: "Longites." *Longites.*
- 30: "Haſtiformis. 1." *Spear-shaped. 1.*
- 29: "Enſiformis. 4." *Sword-shaped. 4.*
- 31: "Haſtiformis. 2." *Spear-shaped. 2.*
- Lower left: "Fig I"
- Lower right, inside the plate mark: "Autor ſculpſit." *Engraved by the author.*

verse conjunction and aggregation of matter and nuclei, such wonderful torches can be produced, at times like the hilt of some sword or dagger: such as, namely, you see sketched in delineation 27.

Around the year of Christ 400, or, as Lavath. would have it, 403, a comet of almost the same face was seen. Of it Nicephorus, Book XIII, Chap. 5; Socrates, Book VI of the *Ecclesiastical History*; and likewise Sozomen, Book VIII, Chap. 4, have handed down this to memory: *Around the year 403 Gainas* (an Arian general) *had it in mind to lay waste the city of Constantinople, and was planning to plunder it. That plot was portended by that star of the form of a sword* (a comet), *which was splendid beyond measure* (*such as, it is recorded in the memory of letters, had never appeared before*), *shining over the city itself, and reaching from almost the highest heaven down to the earth:* It was without doubt of such size that, with its head placed around the zenith, it touched the horizon itself with its tail.

[Margin: Inſignis & ſplendidisſimus Cometa enſis ſpeciem referens.] *A remarkable and most splendid comet, showing the form of a sword.*

But the third kind of Xiphiae, the curved one, appears in the manner of a scimitar [acinacis] or Persian sword, as the face of comet 28 clearly shows. Such a comet, in the year of Christ 1099, namely around the Nones of October, they saw in the southern region, stretching out its splendour obliquely in the manner of a sword; on the authority of Lavatherus. And hence it cannot be denied that this one was Scimitar-shaped [Acinaciformem]. Of this kind still others can easily be given, which are seen with a hilt not so distinct, but in some way rougher; nevertheless, if they have oblique tails, they are rightly counted in this number.

[Margin: Cometa inſtar acinacis.] *A comet like a scimitar.*

Besides these, quite other ones still sometimes come our way, of the kind of the Xiphiae, with a face truly wonderful, like a romphea [Rompheæ], that is, an oblong and large sword, or a two-edged one. Georgius Phranza, Book V, Chap. 21 of his History, reports that a similar one appeared in the year of Christ 1450: *For in the time*, he says, *of the year of Christ 1450, a comet began to appear above the horizon every evening immediately after sunset, in the likeness of a romphea; and passing under the full orb of the Moon, it produced an eclipse, according to the order and the customary motion of the heavenly lights in their circuit. Some, seeing that this comet expressed the form of a sword, and moved from west to east, and approached the Moon, and [seeing] the darkness of that eclipse, interpreted the matter thus: that, a conspiracy having been made, the Christian princes would come against the Turks and defeat them utterly. The Turks too fell into no slight fear at that portent.* We have given it under number 29, drawn as far as it was possible to attain.

[Margin: Cometa inſtar Rompheæ.] *A comet like a romphea.*

[Margin: CometaLunam eclipſavit.] *A comet eclipsed the Moon.*

By this example (which, however, I would wish to be said here only in passing) the Reverend Father Riccioli tries to demonstrate that the comet was lower than the Moon, since it covered the Moon. That this certainly happened so, I freely concede: namely, that the Moon was hidden by the comet at that time. But in truth it does not follow from this that the comet first took its beginnings in that place, and was never higher than the Moon, whether at the beginning or at the end; but from this only this is concluded: that at that time it was lower than the Moon. But according to our hypothesis a comet can be generated even around Saturn itself, and be carried with such a motion that it sometimes passes even through our sublunar air into the opposite aether; so that a comet can at one time be lower than the Moon, at another again higher; and it is by no means necessary that, being below the Moon at a certain time, it proceeds in that same place for its whole duration. But it is not to the purpose to say more about these matters here; they will have to be deferred to the following Book IX.

[Margin: An Cometa aëreus extiterit ?] *Whether the comet was aerial?*

Let us return, then, to describing the remaining comets, and indeed the Longites, which for the most part displays the form of a lance or spear. That such a comet was observed at Constantinople very many writers testify with one voice: namely Albertus, Abbot of Stade [Abbas Stadenſis], Lycosthen., Sigebertus, Funccius from the *Annals of Constant.*, Lavath., Praetorius and others. For in the year, they say, 557 of the salvation-bringing birth, a haired star appeared in the form of a lance. A likeness of this kind is to be seen in image 30. Likewise in the year of Christ 1402, a comet for many days, which stretched upward in the manner of a lance, three feet thick, sometimes less. *Hist. Landg. Thuring.*

[Margin: Cometæ, formam Lanceæ referentes.] *Comets presenting the form of a lance.*

Under number 31, moreover, you will have the form of a spear-shaped [comet]; with such a face a certain comet was seen in the year 348 before Christ, of which Pliny, Chap. 25, Book II, tells this: *Once up to now the image of a trumpet* (or of a mane, as others would have it) *has been changed into a spear, in the 108th Olympiad, in the 398th year of the City.* Milichius, in [his] *Comment.* on Pliny, affirms that an altogether similar one appeared in the year 1533; and likewise Riccioli, from Fiornovello: namely, that it was of a blackish colour, and had turned its tail toward Africa, and was seen for 30 days in the northern parts. Above all, Fracastoro, fol. 59 of the *Homoc.*, adds that its tail equalled the length of a soldier's spear.

[Margin: Cometa haſtiformis.] *A spear-shaped comet.*

Let us go on to the Spit [Veru]: comets which for the most part stretch out a very long and very thin tail, but display a head sometimes round, sometimes elliptical or oblong. One of this kind shone forth in the year of Christ 1391. For Praetorius noted that a comet having the image of a spit was seen in the said year, and also another in the year of Christ 1402; and, as Riccioli reports from Fiornovello, that this comet had the form of a spit and shone for a month. A similar one too, in the year 1558, in the month of August, was observed for many weeks in Scorpio, with its tail turned toward Rome. It is now shown in Figure 32.

[Margin: Cometæ Veru imaginem referentes.] *Comets presenting the image of a spit.*

Poles [Perticæ], which are species of the Longitae [Longitarum], do not differ much from the earlier ones, except that perhaps, as I conjecture, they are rounder in the head. A haired star of the same form is described by Suessanus, Palmerius and Myzaldus: namely, that a great comet was seen through the month of January, which some called a Pole, others an Ascon [Aſcon]. Albertus Crancius adds, in his *Saxon.*, Book XII, Chap. 12, that it was terrible and had a large tail, namely of 30°. Of these, however, some are occasionally seen which have a very long forked tail, as if displaying two very long rays, as can be seen under number 33. For that reason we also rightly call these forked Poles. Hector Boëtius put on record an example of this kind in the *Historia*

Scot., Book 13, fol. 270: *As Malcolm's fatal day approached*, he says, *etc., fourteen days before the King departed from life, a comet was seen to burn with two very long rays. Malcolm, moreover, died in the year of the Incarnation of Christ 1165.* Riccioli, however, following Cardano, refers it to the year 1169. But no mention at all is made of the head; from this I conjecture that it bore nothing but a common figure, that is, a round one, just as we have given this one drawn.

[Margin: Perticæ.] *Poles.*

[Margin: Pertica bifurcata.] *A forked Pole.*

Let us come now to the square comet, depicted in Figure 34. It consists, for the most part, of an almost quadrangular head, but of a tail very

[Margin: Cometa Quadratus.] *The square comet.*

Diagram. Full-page engraved plate, "Fig. K.", showing eight comets, numbered 32 to 39, set one above another, each with its head at the right and its tail streaming to the left. A caption at the top stands above the first; each comet's label stands at the left above it, with its number at the right near the head. 32: an oval head, longer than it is tall, fringed with short hair and marked with dark cross-hatched spots, with a long, narrow, straight tail of fine strokes tapering to the left. 33: a round head fringed with dense hair and marked with mottled patches, with a tail that splits into two long branches, one running up to the left and one down to the left. 34: a roughly square head fringed with hair and marked with dark spots, with a broad, straight tail of loose, separate strands. 35: an oval head, taller than it is wide, fringed with hair and marked with dark spots, with a tail of straight parallel strokes narrowing evenly to a point at the left, like a cone. 36: a round head fringed with hair and mottled, with a long, feathery tail narrowing to the left. 37: a round head with short rays and dark spots, its tail broken into separate tufts set in a row to the left. 38: a round head fringed with hair and marked with dark spots, its tail broken into separate wavy tufts, the farthest curving away. 39: a round head ringed with looping strokes and marked with dark spots, with a broad tail fanning out upward to the left like a plume. "Fig. K." stands at lower left and the engraver's line at lower right. All labels on the plate are listed below; none is supplied from the text.

- Caption: "Acontiæ." *Acontiae.*
- 32: "Veru." *Spit.*
- 33: "Pertica bifurcata." *Forked Pole.*
- 34: "Cometa quadratus." *Square comet.*
- 35: "Coniformis." *Cone-shaped.*
- 36: "Cometa Pÿramidatus." *Pyramidal comet.*
- 37: "Cometa Monstriferus. 1." *Monster-bearing comet. 1.*
- 38: "Cometa Monstriferus. 2." *Monster-bearing comet. 2.*
- 39: "Cometa Monstriferus. 3." *Monster-bearing comet. 3.*
- Lower left: "Fig. K."
- Lower right, inside the plate mark: "Autor ſculpsit." *Engraved by the author.*

long, very dense and uniform; that is, almost equally broad and condensed on every side: otherwise not unlike a Beam [Trabi]. Besides, it presents a fiery colour and also a dreadful brightness. Of that order was the one that appeared in the year 372 or 373 before Christ, which Seneca, Book VII, *Natural Questions*, Chap. 4, mentions in these words: *Charimander too, in the book that he composed on comets, says that a great and unusual light in the sky, of the size of a broad beam, was seen by Anaxagoras, and that it shone for many days. Callisthenes reports that the long fire had such a likeness before the sea hid Buris and Helice.* Aristotle speaks of it in Book I, Chap. 7, *Meteorolog.*: *When the great star too, which we mentioned earlier, appeared in winter, in frost and clear weather, in the evening, while Aristaeus was ruling; and on the first day it did not appear, as far as is possible, for it fell short by the least amount; and it soon set; but its light extended as far as a third part of the heaven, like a leap, for which reason it was also called a path: and it rose as far as the Belt of Orion, and there it was dissolved.* In the year 763 after Christ a comet in the figure of a Beam shone again, as the German Rhymes [Rithmi Germanici], published without an author, have it; others called it *Doceten*, as Lycosthenes notes. Likewise, *in the year of Christ 1017, the fifteenth year of Henry the Saint, such a comet, more wonderful than usual, appeared in the manner of a very large beam for four months*, as Sigeb., Lycosth., Myzaldus record. Almost the same likeness was borne by the middle one of those [comets], which was observed at Rome in the year 1618, as Kepler testifies in *De Com.*, p. 51. And although others have reported this comet as though it had appeared like an ostrich feather, the Roman observation nevertheless proves that it was itself like a Beam, but slightly arched; for the author just mentioned writes: *But at Rome on November 11 a fiery beam was seen toward the east*; and the observer's words are added: *Like a slightly arched beam, in a more accurate observation, which was made on November 10 from* $16^h\ 20^m$ *to* $18^h\ 40^m$.

[Margin: Cometa Trabis Figurâ.] *A comet in the figure of a Beam.*

Nor do I doubt that more comets of the same kind were seen in former ages, had they only been consecrated in the monuments of letters. It is surely credible that among those which shone forth terrible in face, with an immense and fiery tail, one or two were of this kind: for instance the one that shone out in the year 119 before the birth of Christ, of which Justinus, Book 37, has this: *For both in the year in which he was born and in that in which he first began to reign, a comet star shone through each period for seventy days in such a way that the whole heaven seemed to be ablaze. For in size it had occupied a fourth part of the heaven, and in brightness it had surpassed the splendour of the Sun; and in rising and setting it took up a space of four hours.* Our History of Comets will amply show that [comets] of this kind, of wonderful size, were also seen in the years of Christ 945, 1106, 1240, 1264 and 1471. Above all, however, the one that appeared in the year of Christ 1264, when Pope Urban was dying, with a very long and very broad tail, is to be counted among the Square [comets]. But I would have you note that when we speak of Beams we by no means understand sublunar meteors, but always haired stars displaying themselves in the form of a Beam.

For we have set out to describe and delineate here no sublunar bodies at all, but only those aetherial bodies of the comets.

[Margin: Cometæ terribiles.] *Terrible comets.*

[Margin: Cometa, qui Sole clarior fuit; & cujus cauda quartam Cœli partem occupavit.] *A comet which was brighter than the Sun, and whose tail occupied a fourth part of the heaven.*

Now, since I seem to have said enough about the Square [comets], I move on from these to the remaining species of haired stars, of which mention is made here and there in the Histories. There is found, moreover, a certain [comet] having the form of some cone or turning-post [metæ], whose tail runs out into a very sharp point, or a pointed tip, with no vibrating rays at all, or fiery ones adhering; such as is delineated in Figure 35, and such as also appeared in the year of Christ 409. Nicephorus writes of it: *Then indeed there was so great an eclipse of the Sun that the stars shone at midday. And when the Sun, a certain brightness appeared at the same time in the heaven, bearing the form of a Cone or Comet.* That this phenomenon was altogether a genuine comet, there is no reason for anyone to doubt. For it is nothing absurd that haired stars rather often lie hidden under the Sun's rays; and unless they free themselves from its rays by some motion, either faster than the Sun's or contrary to it, or emerge at the time of an eclipse of the Sun, they in no way come into our sight. This agrees with the saying of Seneca, Book VII, Chap. 20, *Natural Questions*: *Many comets*, he says, *we do not see, because they are obscured by the rays of the Sun: Posidonius reports that when the Sun was eclipsed a certain comet appeared, which the neighbouring Sun had covered.* As will perhaps be set out more fully in its proper place.

[Margin: Cometa Coniformis.] *A cone-shaped comet.*

[Margin: Stella comata tempore Eclipſeos Solaris conſpecta.] *A haired star seen at the time of a solar eclipse.*

Moreover, in the following drawing, 36, almost the same face is seen, except that the head tends more toward a round shape, the coma being likewise pointed and pyramidal. Of these, certainly, very many have been observed in the likeness of pointed columns and conical pyramids, as also in the year 1558 after the birth of Christ. Praetorius indeed attributes to this one the image of a Spit; but Cornelius Gemma in his *Cosmocritica*, and also Aldrovandus [Aldrovandi] in the *Monstrorum Historia*, assert that it was rather cone-shaped. Among these I consider that ours of the year 1652 is also to be counted, as its genuine likeness clearly shows. And this figure of comets is almost the most frequent of all. For even if they do not shine with this same face immediately at the beginning, yet in the course of time they degenerate into this pyramidal and pointed form. An example is at hand in the comet of the year 1577, observed by the excellent Tycho: its mane at the beginning, on November 13, was broader near the end than in the middle, as is clear from p. 2 on that same phenomenon; but a little later, on the 15th, the observer says: *It no longer seemed so broad at*

the end, but rather was seen pointed this evening. This would not be difficult to demonstrate with more comets, if one had to dwell on them longer.

[Margin: Cometa pyramidatus.] *A pyramidal comet.*

[Margin: Cometæ cuſpidati, & pyramidati omnium ſunt frequentisſimi.] *Pointed and pyramidal comets are the most frequent of all.*

Finally, those two images that are shown under numbers 37 and 38 present a monstrous or monster-bearing species of comets, in the likeness of a beast. These comets indeed take on a varied form as regards the head, as is usual with all; but with respect to the tail they have something singular, beyond all the rest. For the train [ſyrma] is not seen continuous at all times, but sometimes as if interrupted here and there, and cut through: just as if some part of the tail were covered by another dark and denser body, or absorbed by the aether, so that it can by no means be seen there at that time, however much you direct the full keenness of your eyes on this phenomenon. It does not, however, always present itself in the same way, as you easily gather; for now the coma is hidden near the head at the very beginning,

[Margin: Cometæ monſtriferi.] *Monster-bearing comets.*

and vanishes; now in the middle, and indeed in various ways, the hairs are cut off and perish altogether; now elsewhere again (yet along the same straight line, and turned away from the Sun, or slightly inclined, or curved) they break out and, as it were, boil up. Rothmann too recognizes such wonderful tails, in a letter sent to Tycho, p. 126: *that*, namely, *the tail is scattered, and its rays are not continuous, but sometimes begin to appear abruptly far behind the head.* Fortunio Liceti agrees with this, Book I, Chap. VII; likewise Book II, Chap. 75: *In some comets*, he says, *the tail has been seen broken off into several parts.* Since these comets evidently flash forth with a beast-like appearance, it pleases [me] to call them Monster-bearing [Monſtriferos]. Here, however, it should be understood that not all of them are always alike, but they may be very different, according to the extension and face of the coma, now straighter, now more curved. To this class, therefore, all those seem to belong that come forth in some altogether strange and unusual form: such as the one that was present in the year 1577 and showed, as it were, two distinct tails, with another very clear ray shooting out almost in the opposite direction; we shall soon bring it into view in the following diagram. Likewise the one that appeared in the year 1098 put forth a double hair, the larger toward the east, but the smaller toward the south-east [Euroauſtrum], on the authority of Lycosth. and Rockenb.

[Margin: Cometa anni 1577, admirandam caudam exhibuit.] *The comet of the year 1577 displayed a wonderful tail.*

Lastly, the one that imitates a peacock's tail and shoots out a very broad coma, or very brilliant spreading rays, is also not wrongly assigned to this order of Monster-bearing [comets]. Such a one was detected in the year of Christ 1401, at the end of February, horrible to see, having an outspread tail like a peacock's, as Rockenbach [Rockenbachio] testifies. Its image is under number 39.

[Margin: Cometa caudam Pavonis referens.] *A comet resembling a peacock's tail.*

And these are the principal species of all those comets that could ever be found in the records of the ancients. I have no doubt at all that, with these things thus accurately set before the eyes, no common light will come to our cometographic undertaking, for unravelling and understanding more exactly all those things that still remain to be said about the tails of comets, as the matter itself will soon declare. But since, besides these, there remain other, altogether different species of comets, which seem to differ from those above in many respects, and in which some more particular features occur that have so far not yet been expressed for lack of observations, we have judged it advisable to bring to light certain singular haired stars, described with care by the more recent [writers] in recent years, together with the images of the newest ones, of the year 1652 (for whose sake we gladly undertook this whole labour) and also of 1661, carefully delineated. For I really do not know whether they have yet been portrayed by anyone as accurately as the matter indeed demands (be it said without offence), even though they have been described diligently enough. These faces, as they without doubt cannot fail to be pleasant and welcome to lovers of the stars [Aſtrophilis], will also — be it [?] so, with GOD Best and Greatest helping — unlock for us a door to the tracing out and uncovering of very many secrets of nature. So be it! But to the matter itself.

[Margin: De recentioribus quibusdam Cometis, notatu dignisſimis.] *On certain more recent comets, most worthy of note.*

It certainly cannot be denied that, from the very beginning of the World, a great many comets have shone; yet of these, I believe, a record of very few survives among the authors. For although I have turned over the Annals of both the ancients and the moderns as diligently as possible, I have been able to find scarcely 250 recorded, as our little History of haired stars itself will clearly attest. What? That of these

[Margin: Quot Cometæ fuerint obſervati, à Mundo condito.] *How many comets have been observed since the founding of the World.*

most have so far been handed down to us so meagrely that, beyond the year, the month and day of the first appearance have seldom been recorded; while all the rest, however supremely necessary it would have been to note, concerning namely the motion, the magnitude, the colour and the changes of the tails, has been passed over entirely in deep silence. So that no comet at all (though I would say this with the leave of such great men) was described by anyone duly and accurately, as would have been fitting, before the times of Tycho, that great Restorer of Astronomy, much less exquisitely observed and delineated. Therefore, although I should very much have wished to add some further particulars about those older comets, it was by no means possible to do more. For that reason, leaving all of them now, let us betake ourselves to the comet detected by Tycho Brahe in the year 1577. For this was the first of all to be duly and studiously investigated, and also described at considerable

length, so that we may now delineate its genuine face without great trouble. With this comet, I say, let us begin; then let us likewise append the figures of the other principal ones, so far as it lies in our power; and so, lastly, let us conclude with ours of the years 1652 and 1661. In each one, believe me, certain singular features will become known, whose causes it will not be beside the point to inquire into afterwards. All the comets, however, that still remain to be delineated are species of the Pogonias, or the Tailed [comets]; yet each one enjoys an altogether singular figure, as the delineations and the following description show.

[Margin: Ante Tychonem, vix ullus Cometarum debitè obſervatus eſt.] *Before Tycho, scarcely any comet was duly observed.*

[Margin: Cometa 1577 primus omnium ritè detectus, ac deſcriptus eſt.] *The comet of 1577 was the first of all to be duly detected and described.*

And so, as regards first the comet of the year 1577, delineated under number 40: Tycho described it in the Proem to Book II on the same [comet], in these words: *In the year 1577 from the birth of Christ, as it ran its course, on about November 10, another unusual star, very different from the former, pouring out long hairs, was shown near the setting part of the heaven; its body was round, bright, and conspicuous with a certain slightly livid whiteness. But the tail, which stretched out mostly toward the east, as if into the parts opposite the Sun, blazed with rather reddish rays, which were the denser and the more apparent the nearer they were to the head; near the end, however, being sparser, they conveyed less light and colour to the eyes. Moreover, the tail itself was somewhat curved, so that it turned its convexity to the zenith and its concavity to the horizon.* Likewise a little later, p. 2: *On November 13 I took the size of the diameter of the head itself, as soon as it appeared whole after sunset, and found it to be very nearly 7′. The length of the tail, which stretched as far as the horn of Capricorn, I found to amount to almost 22°, although the very end, because of its thinness, did not lie open to exact observation, so that on this account it follows reasonably that the tail was in fact a little longer than it appeared.* He adds besides: *And it was bent in an arc, as I said above, and broader at the end, and a little wider than around the middle.* And if we believe Kepler, it had a divided tail, as is clear from his *Phisiol. Comet.*, p. 102.

[Margin: Deſcriptio Cometæ an. 1577 à Tychone tradita.] *The description of the comet of the year 1577 given by Tycho.*

[Margin: Cauda erat incurvata.] *The tail was curved.*

But the most skilful Cornelius Gemma noted the head and tail of this comet still more accurately, in a little work published about it, p. 20: *To us*, he says, *this star first appeared on November 14, toward* 5^h*, among thin vapours, blazing with a horrible aspect, the colour of its body entirely bright, like the purest silver lightly tinged with red, of the size of Venus or of Jupiter at distances [longitudinibus] that are me-*

[Margin: Exquiſitæ annotationes Cornelii Gemmæ ſuper eundem Cometam.] *Cornelius Gemma's exquisite notes on the same comet.*

Diagram. Full-page engraved plate, "Fig. L", showing eight comets set one above another, each with its head at the right and its tail streaming to the left. Each label stands at the right between two comets, with a number below it just above the next comet's head; the numbers run, from top to bottom, 40, 41, 42, 43, 46, 44, 45, 47. 40: a round head with jagged, star-like rays and dark spots inside a ring, with a long tail curving up to the left in two branches, the upper one longer, a dotted line running along it. 41: a round head with jagged rays and dark spots, with two long tails curving up to the left, and thin straight rays from the head, one running to the right, one down to the left and one straight down. 42: a small round head fringed with short hair and marked with spots, with a narrow, straight tail of loose strokes. 43: a large round head fringed with wavy hair and marked with dark patches, with a broad, straight tail. 46: a round head with short rays and dark marks, with a long tail of loose, straight strokes spreading to the left. 44: a round head with a spiky fringe, an inner ring and a dense dark core, with a very broad tail widening to the left, two small stars engraved in it. 45: a round head with a spiky fringe and dark, clover-like spots, with a broad, curved tail sweeping down to the lower left, three small stars engraved in it. 47: a large round head with a fine fringe, faint horizontal hatching, small dots and darker shading at its right, with a straight tail of fine parallel strokes. One label stands at the left, below the tail of the comet numbered 45. "Fig. L" stands at lower left and the engraver's line at lower centre. All labels on the plate are listed below, in order from top to bottom; none is supplied from the text.

- Label above 40: "Cometa 1577 Die 13 Nov." / "à Tÿchone obſerv." *Comet of 1577, November 13, observed by Tycho.*
- 40: "40."
- Label above 41: "Cometa 1577 Die 28 nov. et 3 Dec." / "à Cornel. Gemma obſerv." *Comet of 1577, November 28 and December 3, observed by Cornel. Gemma.*
- 41: "41."
- Label above 42: "Cometa 1590." *Comet of 1590.*
- 42: "42."
- Label above 43: "Cometa 1607." *Comet of 1607.*
- 43: "43."
- Label above 46: "Cometa 1647." *Comet of 1647.*
- 46: "46."
- Label above 44: "Cometa 1618 Die 1 Dec." / "à Cÿſato obſerv." *Comet of 1618, December 1, observed by Cysat.*
- 44: "44."
- Label above 45: "Cometa 1618, Die 17, 18 et 20 Dec. obſervatus." *Comet of 1618, observed on December 17, 18 and 20.*
- 45: "45."
- Label at the left, below the tail of 45: "Cometa 1652 ab Autore obſerv." *Comet of 1652, observed by the Author.*

- 47: "47."
- Lower left: "Fig. L"
- Lower centre, inside the plate mark: "Autor ſculpsit." *Engraved by the author.*

an in the epicycle: so that at first sight many would indeed have declared that hair had been fixed to the body of some planet. The tail, however, was of an almost blood-red colour, from the vapours mixed through it, although afterwards, when the air had been cleared, the same tail, brighter, showed the eyes a mixture of bronze and lead. It was thrown out a long way toward the part opposite the Sun, yet so that, curving, it bent itself little by little toward the line of the winter rising, and to a place a little above the horns of Capricorn. Its form, by Hercules, was rare, and I do not know whether one like it was ever seen anywhere in another [comet]. For it rose not with rays refracted in a straight line but with rays bending into an arc, with a neck that was narrow indeed, set into a small head, but one that was (as we said) extremely bright and, as it were, peculiarly outlined. From there, widening little by little, it was carried out to the length of half a sign; although its splendour, or its utmost fading, easily reached as far as the 20th degree, especially around the beginning of December. The extreme breadth of the tail was bounded by scarcely 5°. Lastly, it was remarkable for its brilliance, and the reflection of the rays was dense toward the north, and, little by little, darker and sparser and more mournful toward the south. The appearance of the figure was κερατοειδὴς [Greek: κερατοειδὴς (keratoeidēs, "horn-shaped")]*, of the kind that in Alkindus generally received the name of "soldier", although it might also more correctly be called the* ἱππίτευς [Greek: ἱππίτευς (hippiteus, "horseman")] *of the Greeks, because a certain continuous projection stood out from it like a second tail, downward and obliquely, or toward Euroafricus, while the rest of its radiance gave the very best image of a very broad horn, or of a peacock's tail, or of a soldier's plume. But let what has been said of the figure, of the quality of the light, and of the refraction suffice.*

[Margin: Facies Caudæ.] *The appearance of the tail.*

[Margin: Longitudo & latitudo Caudæ.] *Length and breadth of the tail.*

Further, on p. 25 he adds: *On November 28 the sky, clearer after a most savage storm, showed the eyes of the onlookers the mass of the haired star much narrower than before. For then too, plainly, something like a branch of another tail flowed downward from the same neck and head, persisting so for very many days, until the whole mass burned out, whether it was gradually dispersed or withered. So it stood, bearing the likeness of a wing now fully spread; the end of its aponeurosis [aponeuroſeos] had reached beyond the nostrils of Pegasus.* Likewise on p. 27, he says: *On December 3, around the eighth hour, something rare and wonderful beyond all the rest befell this prodigious torch. For to many who were observing more attentively at that time it seemed suddenly to split open and to hurl three huge rays, like fiery spears, little by little toward the Mediterranean sea; and trustworthy people steadfastly assert that, the first shaft once launched, it made straight for Italy, with the second for the Herculean shore, and lastly for the western region: the first (I say) with its line running out at oblique angles, the second as if perpendicular, the third crosswise and as if at right*

angles. No outflows worth mentioning are recorded as observed toward the north, or the upper parts. Many also record a similar apparition on the feast of the Epiphany, from the same part of the sky, but with a darting of the most brilliant light and a more powerful ἀπόθραυσι [Greek: ἀπόθραυσι (apothrausi, "breaking-off")] *of the rays, around the sixth hour.* So far he.

[Margin: Singulare phænomenum Caudæ.] *A singular phenomenon of the tail.*

[Margin: Cauda ingentes igneos vibrabat radios.] *The tail hurled huge fiery rays.*

From all this, no one can now be unaware with what face and tail it shone: namely, that it was of the species of the Ceratiae, or Horned [comets], not unlike that twentieth delineation, just as we have given it sketched in the attached Figure L under number 40. I composed the head, moreover, of those nuclei and little bodies by which I thought I could express its colour correctly. Near its end the train showed itself far wider than near the middle. But above all, this occurs as especially worth noting: that on November 28 this comet was endowed with another, smaller tail projecting toward the south; and also on the 3rd of Decem-

[Margin: Maximè notanda in Cometâ anni 1577.] *Things most to be noted in the comet of the year 1577.*

ber shot out, in an altogether unusual manner, as it were three bright rays into different regions of the sky, one of them into the part directly opposite the tail, namely toward the Sun: just as delineation 41 shows this prodigious radiance. This phenomenon is surely to be wondered at above all the rest, and easily earns the foremost place [partes anteſignanas], since nothing of the kind, so far as I know, has ever been detected in any other comet. What the cause of this may be, however, we shall unravel below.

Now the order reaches the comet of the year 1590, likewise observed by the most noble Tycho; we set it out for viewing in image 42. In head and tail it was smaller than the former, and also far paler in colour, as is clearly evident from the description to the Landgrave of April 1 [Calend. Aprilis]: *In appearance*, he says, *it was not so very large, but shone with a pale and somewhat dark face between the asterisms of Andromeda and Aries, next to the northern Fish, etc.* Likewise in the following letter, or rather in the description of the same comet: *This comet was observed for 12 whole days, namely from February 23 up to March 6. Its head, indeed, a little larger at the beginning than afterwards, yet held scarcely 3′ in diameter, and was thereafter successively diminished. It also appeared somewhat dark, less compact, and not shining like the other stars. Its tail, too, very thin and rather sparse, it directed exactly toward the parts opposite the Sun for as long as any tail could be noticed. For on February 23 it extended it precisely toward the brighter [star] in the left foot of Andromeda.* Accordingly this haired star, as it seems, is to be counted in the order of the Acontiae. Tycho, however, did not describe its coma clearly enough, so that it is not known whether the tail appeared pointed near its end like those of the Javelin-shaped [comets]? Yet

I should believe, since he did not expressly add it, that it was spread out and dispersed, pointed [?], [and] shone with the common form.

[Margin: Deſcriptio Cometæ an.1590.] *Description of the comet of the year 1590.*

Other comets, it is true, followed this one a little later, namely in the years 1593, 1596 and 1597; but since their true appearance has by no means been handed down to us, we must pass them over. Let us therefore come to the comet of the year 1607, carefully recorded both by Severinus Longomontanus and by Kepler. Of it the former reports the following in his little book on the new phenomena of the heaven, Chap. IX: *In the year of our Saviour Jesus Christ 1607, on September 18, in the evening, I noticed and at the same time observed a tailed comet in the north, which in its size rivalled almost Jupiter himself to the sight, but in its darker, that is slightly livid, colour Saturn himself. It also had a tail fairly long and dense, which the solar rays drove straight into the region turned away from them, and this through the whole duration of the comet.* He adds: *The comet's tail was also dense, as I said, and perhaps more compact than the others usually are, and of the same colour as the head itself, namely livid and somewhat Saturnine.* Kepler, for his part, sketches the comet observed on the 26th, Old Style [St.V.], in *Physiolog. Com.*, p. 117, in these words: *To one looking at it carefully, the shape of the head seemed somehow lumpy [ſtrumoſa], falling short of roundness. Its size was greater than all the fixed stars; its light weak, pale, watery, like that of the Moon standing near the shadow of the Earth, and it spread out less in my eyes than that of the fixed stars. After the last full Moon, although the Moon was still bright, the tail could be seen more clearly, now short and suddenly quite long, up to 8° and 10°, flickering like the rods of chasmata.* Its likeness Fi-

[Margin: De Cometâ anni 1607.] *On the comet of the year 1607.*

[Margin: Cauda admodùm extitit denſa.] *The tail was very dense.*

[Margin: Caput à rotunditate defecit.] *The head fell short of roundness.*

[Margin: Vibratio Caudæ.] *The flickering of the tail.*

gure 43 now shows: you will scarcely find any like it among the earlier ones. Hence I am almost in doubt into which class of comets it should be put here. But since it displayed very many separate and diverging rays, and was, as it were, lumpy [ſtrumoſus], it could be counted among the Ceratiae and the Tube-shaped [comets] [Tubiformibus], and so, by way of distinction, be called the Lumpy Tube-shaped [comet] [Tubiformis Strumoſus] [?]. In this I should like you to note the following: that the coma at its outflow [in eductione], near the head, was so dense that it was almost like the head itself, and certainly far more packed together than usually happens in other haired stars. When the matter allows, this phenomenon will furnish us with a little question that is by no means trifling.

In the year 1618 it was followed by another comet, which truly dazzled everyone's eyes with its most brilliant rays: namely the last and the greatest (for besides this one, as Riccioli holds, three others were seen); and it is rightly so called because of the prodigious length and brightness of its tail. To speak

with Kepler and Wendelen, we have seen none at all equal to it in the past 150 years. It therefore deserves first to be described properly, though briefly, in this place, and then also to be presented accurately drawn, as you also see done in Figure 44.

[Margin: De ſplendidiſſimo Cometâ anni 1618.] *On the most splendid comet of the year 1618.*

It was first noticed on November 24, in Bohemia, at Budweis [Budovici], by the Imperial army, or, as Wendelen notes, on the 23rd; and it was observed by Cysat up to January 22 of the year 1619, that is, for 59 days. At the beginning of its appearance it was endowed with a clear light and with a most splendid head and tail; or, as Crüger puts it in the *Uranodromus Cometicus*, it appeared great and huge in head and coma. Its tail was curved and of immense length, sometimes running out to 50°, 60°, 70°, indeed 100°, according to Longomontanus. Its colour, namely on November 29, was partly yellow, partly ruddy, and it flashed out so that it was sometimes long, sometimes short; it spread out from the head like brooms, straight and stiff. The head, viewed through the telescope, was round below, but above it faded away into hairs; its brightness was greater without the telescope than through it. Moreover, the tail swelled toward the north in its curvature; and if we believe Schickard, the northern edge of the tail was faint, while the southern stood out suffused with a conspicuous light and ran out further. Wendelen adds: *The tail, drawn out according to the motion of the head, was moderately curved like a horn; and on the side, quite smooth, by which it cleft the aether for itself, it was denser and more compact, but behind it was looser and shaggier, and as it were feathering out, so that it could not unfittingly have been compared with the spadix of a palm. Its length exceeded 56° from the head, growing gradually wider in the manner of a ray of the Sun let through a tiny hole into a darkened room [inobſcurum conclave], which the motes make visible; in just that manner the comet's cone came to a point at its head, and behind it spread out in breadth to easily 5° where it was widest and farthest from the head. The colour of this tail near its head was fiery and glowing red, and from time to time, with certain flashes, as it were, of lightning and with sparks, it imitated the slackening and the intensifying of a fire that comes and goes, as those rods usually do which we sometimes see quivering at night. If ever I saw a fire, this certainly was one; but one such that it then left the rest of the tail fair, white and shining.* In *Teratolog. Com.*, p. 20.

[Margin: De primo ejus exortu.] *On its first appearance.*

[Margin: Longitudo Caudæ.] *Length of the tail.*

[Margin: Caput.] *The head.*

[Margin: Cauda inſtar cornu apparuit.] *The tail appeared like a horn.*

[Margin: Color Caudæ,] *Colour of the tail.*

Best of all, however, Father Cysat recorded this same comet. In Chap. IV, p. 62, *de Comet.*, he set down very accurately, in these words, not only the true constitution of its head (in what way it was compounded of various nuclei that varied in succession, as was shown at length in Book VI, p. 341), but above all also the true appearance of its tail, and how it varied from day to day: *The rays*

of the coma, namely on December 1, *flowed out from the star not perpendicularly, nor in a straight course, but in an arc curved upward and downward (more upward); the diameter of the breadth of the coma was far greater than that of the head* (and indeed about 2°, or even sometimes 3°, as he mentions on p. 64), *and this straight away at B, where the comet's tail was bent both upward toward the zenith and again, sloping downward, around D; and the rays were not scattered in the manner of brooms but (at least beyond A and D) gradually more gathered together, yet not finally forced into a point, but endowed with some breadth even at their furthest end. Further, as far as B the light of the coma was fairly dense, and afterwards rare, so that nearly in the middle of the tail a star of the 5th magnitude shone clearly through.* This appearance of the tail, however, was not found to be always consistent with itself, as is evident from the observation of Orazio Grassi [Horatii Grasſi], Father of the Society of Jesus, then living in Rome, as Riccioli records in Book VIII, Sect. I, p. 18. *For they saw* that *on November 30 the Balance [lancem] had been passed by the comet, the tail being at first 23°, afterwards much longer; along its middle, lengthwise, there ran a bright and distinct line, like the pith of a tree; the tail, moreover, was somewhat curved, and stretched from the right foot of Virgo toward her knees.* Having therefore taken account of all these circumstances as far as could be done, we have now given the appearance of this comet drawn in Figure 44. The proportion of the length, it is true, as in all the rest, was by no means so strictly kept, because of the narrowness of the paper, so that the head might be expressed all the more accurately for December 1, when it still consisted of a single, as it were, very large nucleus. The other variations of all the days are found in Book VI, p. 341, and Book VII, p. 414, and I send the reader to those places to view them.

[Margin: Omnium exquiſité Cyſatus eundem Cometam delineavit.] *Cysat drew this same comet most exquisitely of all.*

[Margin: Caudâ non perpetuò ſimili luxit facie.] *It did not always shine with a tail of the same appearance.*

[Margin: Inſigne caudæ phænomenum.] *A remarkable phenomenon of the tail.*

This remarkable comet was followed, so far as I know, by no other than the one that shone in the year 1647. About that one, I believe, scarcely anyone has learned anything certain up to now, for it was noticed only for a few days, since it was very close to the Sun and also, without doubt, directed its course toward the Sun. [It was noticed] not, indeed, here in Danzig, because of the continually cloudy sky, but at Marienburg [Marieburgi] in Prussia, namely on September 29, in the evening at $8\frac{1}{2}^{h}$, immediately after sunset, by a certain friend, who sent it to me drawn quite carefully, just as he had seen it that evening, with all the surrounding stars. I have gladly wished to attach this drawing here as well, so that its position and the direction of its tail with respect to the other stars may be known all the more accurately. It is clear, moreover, that this comet stood in the constellation of Berenice, not very far from the left shin of Boötes, at least 5°, on the south side more or less 10°, and from the left

shoulder nearly 23° or 24°. Toward this star it also directed its coma, which nevertheless inclined a little toward the left elbow of Boötes, to the right; and its point indeed upward toward the zenith, so that it looked like a soldier's spear. For since the comet, no more than 5° or 6° above the horizon, was ele-

[Margin: De Cometâ anni 1647.] *On the comet of the year 1647.*

[Margin: Cometæ locus, & Caudæ directio.] *The place of the comet, and the direction of its tail.*

Diagram. Full-page engraved plate, "Fig. M.", showing a single comet among the stars. The comet's round head, fringed with short spikes, finely hatched and with a dark dot at its centre, stands low in the middle of the plate, and its tail of fine straight strokes rises straight up from it, widening a little toward the top. Around it are stars of several sizes, engraved as six- and eight-pointed stars, none of them lettered. The title stands in three lines at the upper centre and right. At the left stand the labels for the shoulders and for Boötes, with a group of stars below them, and lower down the label Arcturus above a large star; the label for the left shin stands to the left of the comet's tail, above a star; at the right stand the label "under the tail" beside a star, and lower down, to the right of the tail, Coma Berenices. "Fig. M." stands at the lower left and the engraver's line at the lower right. All labels on the plate are listed below, in order from the top; none is supplied from the text.

- Title, upper centre and right: "Cometa" / "Anno 1647, Die 29 Septembris," / "Marienburgi in Borusſiâ obſervatus." *The comet observed at Marienburg in Prussia [Borusſiâ] in the year 1647, on September 29.*
- Upper left, between two stars: "Humeri." *The shoulders.*
- Left, below it: "BOOTES" *BOÖTES*
- Right, beside a star: "Sub caudâ u.m." *Under the tail [of] u.m.*
- Lower left, above a large star: "Arcturus" *Arcturus*
- Lower right, right of the tail: "Coma Berenices." *Coma Berenices.*
- Lower centre left, left of the tail: "Sinist. Tibia." *The left shin.*
- Lower left: "Fig. M."
- Lower right: "Autor ſculpſit." *Engraved by the author.*

vated, and this observation was made immediately after sunset, it could not have been otherwise. The length of the tail was 12°, more or less, quite clear and bright: near the head, at its outflow [in eductione], it was brighter and denser, and toward its end a little fainter and rarer, appearing with its rays spreading apart from one another little by little, so that at its end it looked four times, indeed five times, broader than at the head itself. In addition, it ran out into three or four distinct rays, like a broom come apart [ſcopæ diſſolutæ], while the head was somewhat more compressed, so far as could be judged with the naked eye, and a little smaller than Arcturus. At that time, moreover, it stood in about the 8th degree of Libra, holding a northern latitude of nearly 26°, and cast its tail toward the region opposite the Sun. We now set the likeness of this comet before you under number 46.

But what was the reason that this phenomenon was not detected by others elsewhere? I shall tell you. First, so far as can be gathered, continual bad weather [aëris intempeſtas] over several days was an obstacle. Second, since the comet was only 27° from the Sun in elongation, and without doubt was directing its course toward the Sun, against the order of the signs, namely from the head of Boötes toward the ecliptic and Spica, it could easily happen in this way that the comet vanished [interciderit] within a very few days; just as, if I remember rightly, it was seen at Marienburg for only two days. For granted that this star came nearer to the Sun by fifteen degrees, more or less, it would certainly not have appeared for more than two days, as is easily gathered. For the arc of visibility [Arcus enim apparitionis] of stars of the first magnitude is given by authors as no less than twelve degrees; but the comet, as you have learned, was smaller than Arcturus; therefore, once it was removed from the Sun to a distance of 12°, and that in latitude, its trajectory running from the north pole of the ecliptic to the ecliptic itself, it could by no means be seen any longer. Nor is it absurd [abſonurn] [recte: abſonum] that the comet was at that time endowed with a swifter proper daily motion of this kind, of 7° and 8°; for others sometimes enjoy a far more rapid one. We have an example ready to hand in the comet of the year 1652, which at the beginning traversed nearly eleven degrees of a great circle by its proper motion. Hence it is again clear that the comet could have set heliacally in this way, in due order [ſic ordine], within the space of two days at most. But enough about this phenomenon.

Now, lastly, let us turn to our comet of 1652, which no less deserves some place among the rest because of the remarkable size of its head and tail. And although it has already been described at sufficient length elsewhere, and carefully drawn, we have nevertheless wished to attach it to the other comets as well, so that it may be seen all the better in what respects it agrees with the rest, or differs, and what appearance it presented on December 20 with respect to its tail. But the plan of our undertaking seems to demand that the appearances of the tail be given somewhat more accurately and more fully for each day of the apparition, so that these phenomena may in future be investigated all the more exactly. It should be known, however, that the comet did not shine first of all on December 20, namely when it met our eyes here in Danzig [Dantiſci], but had already shone on us Europeans on December 18, as observed by David Christiani [Davide Chriſtiani] at Giessen of the Chatti [Giſſæ Cattorum] and by Hilario Spinello at Padua; although, as Joh. Kôningk attests, it had been sighted by the Americans as early as December 15, when it came out of Argo Navis [Argonavi].

[Margin: Cometa hic breviſſimæ fuit durationis; & quare ?] *This comet was of very short duration; and why?*

[Margin: De Cometâ anni 1652.] *On the comet of the year 1652.*

So on December 18, at its very beginning, it had a shorter tail and was, as it were, bearded, as David Christiani relates in [his] description [deſcript.] of this comet: *It stretched out its train [Syrma], or rays, toward the east, a span in length to*

the eye. And as Hilario Spinello reports: *it extended a small tail toward the eastern part, somewhat narrowed at the end, about three diameters of the Moon in length.* On the 19th, as the observation from Padua and Cologne [Obſervatio Paduenſis & Colonienſis] attests, the tail appeared almost the same. But on the evening of the 20th, how changed it was from that! For its length appeared as seven degrees; its breadth at the outflow equalled the head; it ran on a straight path and ended in a sharpened point, like a pyramid or a column; it was whitish and somewhat dark, thin, and furnished with no rays spreading apart, or shaggy ones, just as we have drawn it under number 47. On the 23rd, however, the comet displayed a somewhat shorter tail, of about 5°, stretched out toward the eye of Taurus, and also a dark, leaden hue [livorem] and a weak light. On the 25th Albertus Linemannus at Königsberg [Regiomonti], and likewise D. Casp. March at Greifswald in Pomerania [Gryphiswaldiæ Pomeranorum], found that the length of the tail scarcely exceeded one and a half degrees. On the 26th the coma was, to me, scarcely a little longer, namely of two degrees. On the 27th, however, it seemed to us four degrees long, which was also noticed elsewhere by various other observers. From this day on, however, it was diminished step by step, so that on December 30 it appeared very short and almost cone-shaped. Moreover, on the 31st scarcely any trace of the tail was observed, which Linemannus also noted at Königsberg. But whether this phenomenon arose from a different state of the air, or rather from a different position with respect to the horizon, will become clear below. On January 1 of the following year, 1653, the coma did indeed meet the eye again, but it gave off a very dull light. On January 3, however, it was again noticed very well by everyone, even by those whose eyesight was not so strong, at about 2° long. On January 4 it was again shorter and darker, so much so that on the 7th and 8th the comet seemed to be entirely stripped of all its mane [jubâ].

Finally, let us also bring forward here the tail of the most recent comet, that of the year 1661, drawn as accurately as was possible, so that it may at the same time be established with what tail it was furnished, and in what way it changed it from day to day. Accordingly, let us first set out the observations themselves here briefly, day by day; then let us also display those various appearances of the tail, sketched from life, together with a true drawing of the head and the variation of its nuclei; for it was observed and drawn by us twelve times, and indeed at the same time with a most accurate telescope [tubo].

1. In the year 1661, on February 3, the tail was a little more compressed at its outflow by the head than toward its end; for it diverged gradually, so that at its end, with its rays spread apart and shaggy, it appeared nearly 6° in length.
2. On February 5 the tail was seen at only 4°, but with a sharper point.
3. On February 6 the tail enjoyed nearly the same length as on the previous day, except that it seemed a little more pointed still, and also paler and darker; the head, however, was quite bright and conspicuous. In addition, and mark this well, it was darting frequent rays; for this reason the coma

itself was observed now shorter, now longer; through the telescope, however, for the most part thinner and whiter,

[Margin: Initiò barbatus extitit.] *At first it was bearded.*

[Margin: Quâ caudâ ſingulis diebus præditus fuerit.] *With what tail it was furnished on each day.*

[Margin: Obſervationes Caudæ Cometæ 1661.] *Observations of the tail of the comet of 1661.*

[Margin: Quanta initiò apparitionis fuerit.] *How great it was at the beginning of the apparition.*

[Margin: Caudam vibrantem & reciprocantem oſtendebat.] *It showed a tail darting back and forth.*

Diagram. Full-page engraved plate, "Fig. N.", showing twelve drawings of the comet of 1661, each with its date beneath it, in three rows: three in the top row, four in the middle row and five in the bottom row, read left to right in order of date. Each drawing shows the comet's round head, fringed with short spikes and finely hatched, with its tail of fine straight strokes. In the top row the tails are long, broad and spreading, rising up and a little to the left; the first head has a darker, densely hatched centre, and the second and third heads carry several dark spots, the third one larger dark dot. In the middle row the first two tails rise straight up, their heads spotted, the first with one larger dark dot; the last two tails are narrow and slant up to the right. In the bottom row the first and third heads have short tails slanting up to the right; the second, fourth and fifth have none, and the last two heads are smaller, the last without its spiked fringe. Small stars stand in the field, unlettered except for one, which is labelled the Neck of Aquila and stands to the left of the second head of the top row. The title stands in two lines at the upper centre; "Fig. N." stands at the lower left and the engraver's line at the lower right. All lettering on the plate is listed below, in order from the top; none is supplied from the text.

- Title, upper centre: "Cometa anno 1661" / "Gedani ab Autore obſerv." *The comet of the year 1661, observed by the author at Danzig [Gedani].*
- Top row, beside a star: "Collum Aquil." (a star engraved between the two words) *The Neck of Aquila.*
- Top row, under the first head: "Die 3 Februarii." *February 3.*
- Top row, under the second head: "Die 5 Febr." *February 5.*
- Top row, under the third head: "Die 6 Febr." *February 6.*
- Middle row, under the first head: "Die 7 Febr." *February 7.*
- Middle row, under the second head: "Die 10 Febr." *February 10.*
- Middle row, under the third head: "Die 13 Febr." *February 13.*
- Middle row, under the fourth head: "Die 14 Febr." *February 14.*
- Bottom row, under the first head: "Die 17 Febr." *February 17.*
- Bottom row, under the second head: "Die 20 Febr." *February 20.*
- Bottom row, under the third head: "Die 2 Martii." *March 2.*
- Bottom row, under the fourth head: "Die 10 Mart." *March 10.*
- Bottom row, under the fifth head: "Die 28 Martii." *March 28.*

- Lower left: "Fig. N."
- Lower right: "Autor ſculpſit." *Engraved by the author.*

it was advancing between two small stars situated at the head of Aquila, as is clear from the drawing itself.

4. On February 7 the tail was seen at only three degrees; [the comet] cast it straight upward from the horizon, raised like a column.
5. On February 10 the coma was a little thinner and shorter still, and more pointed toward its end, and it appeared to decline from the vertical circle toward the south, its length scarcely exceeding two degrees. In it, near the point, a small star was shining out: namely the neck, or head, of Aquila.
6. On February 13 the tail was not detected at all with the naked eye, because of the Moon, steeped in full light; through the telescope [Teleſcopio], however, it did meet the eye, but equalled only half a degree in length; moreover, it was very pale and dark. Its line of direction, removed by about a degree, stretched toward the south from the bright star in the shoulders of Aquila.
7. On February 14 a faint trace of the tail was detected, because of the presence of the Moon, as I think.
8. On February 17 the comet showed a somewhat brighter tail, and directed it (so far as could be judged) toward the Bright Star of Aquila.
9. On February 20 we noticed no tail at all, as the Moon came nearer and nearer.
10. On February 26 and 27, and also on March 1, the comet was indeed seen, but bereft of its coma.
11. On March 2 we detected with the telescope, quite distinctly, a tail nearly a degree long, tending toward the upper of the unformed stars [informium] (next to the right shoulder of Serpentarius).
12. On March 10 not even through the telescope did any trace of the tail appear (the Moon, that is, being absent); but the head shone almost more distinctly than on March 2.
13. On March 28 the body of the comet did indeed come into view, with the Moon dark [ſilente Lunâ], but nothing at all of the tail.

And these are the most varied forms and appearances of comets, as many as were ever noted and described by the ancients and the moderns [Veteribus & Junioribus]; all of which, as you have seen, we wished to display together in definite images, drawn accurately and vividly [graphicè]. If you want a somewhat fuller description of all of them, please read our History of Comets [noſtramCometarum Hiſtoriam] itself, added toward the end of this work. Now, with the road thus well paved, let us come to the discussion of the matter of tails itself. First, however, it must be inquired whether tails, like the bodies of comets themselves, move and appear in the aether, or rather only in our sublunary air. All those, above all those educated in the Peripatetic School, who wholly take comets for aerial and sublunary bodies set alight, and tails

for flames cast out from the head, certainly cannot do otherwise, as you easily understand, than place the tails in the air together with the bodies of the comets themselves. We, however, for whom the bodies of comets are celestial, hold that the tails too move in the highest aether; not, however, always at the same remove from the Earth, but, according to the distance of the head, now more, now less removed from us. It can sometimes happen, however, that the tail is far nearer to the Earth than the head; although, with the very bo-

[Margin: Comam planè ſursùm Zenith versùs exporrigebat.] *It stretched its coma straight upward toward the zenith.*

[Margin: Stellula in ſyrmate diſtinctè apparuit.] *A small star appeared distinctly in the train.*

[Margin: Omni caudâ exutus videbatur.] *It seemed stripped of all its tail.*

[Margin: Caudam denuò recuperavit.] *It recovered its tail once more.*

[Margin: Quam diu hîc Cometa ab Autore fuerit animadverſus.] *How long this comet was observed by the author.*

[Margin: An Caudæ Cometarum in aëre; an verò in æthere exiſtant ?] *Whether the tails of comets exist in the air, or rather in the aether?*

[Margin: Peripateticorum hâc de re opinio.] *The opinion of the Peripatetics on this matter.*

[Margin: Autoris ſententia.] *The author's opinion.*

dy of the comet, it consists of aethereal matter, as you will soon perceive more clearly. Indeed, it is also consistent with our hypothesis that the tail of some comet may reach almost to the Earth itself, namely when [the comet] is carried through our air; yet it would not remain there long, since the comets themselves do not stay motionless always in the same place either; but because they are in perpetual motion, they are at once carried back again to the upper aether.

Next, no slight question has arisen among philosophers: whether comets cast their tails in every direction, and only by some fortuitous chance toward this part or that, or rather whether they always keep a definite course, and a region of the heavens toward which they tend. On this question absolutely nothing certain was known to the most ancient philosophers and astronomers alike. For since almost all of them were wholly steeped in Aristotelian doctrine, namely that comets are nothing but smoky and dry terrestrial exhalations and evaporations set alight, there was no longer any doubt at all for them that the tails were like flames; and that therefore they either tended continually upward, or toward whatever region of the air the wind, or a rush of air arising from the comet's motion, drove and cast them at will. But they certainly went far astray. For in truth all comets constantly cast their tails toward the parts opposite the Sun. The ancients [Veteres], provided they had examined the matter a little more attentively, would very nearly have learned this even from those rougher observations made long ago. For it was often found, even by the early authors [Priſcis Autoribus] themselves, that when comets stood, for example, in the west, and that in the evening, their tails tended toward the east; conversely,

when they stood in the east in the morning, their tails were directed toward the west. From this they could certainly have concluded, rightly, that the hair [crines] of comets tends toward the region opposite the Sun. Various observations of this kind are ready to hand. 1. For of the comet that shone in the reign of Macrinus, Dio says: *A star stretched out its tail from the west toward the east for many nights.*

2. In the year 519 from the birth of Christ a comet was seen of the form that they call Pogonias [Pogoniam], from its likeness to a beard; it was in the east, and sent out a ray toward the west. Calvis. [Calvif.] and Cedrenus.
3. In the year of Christ 1301, on December 1 [Calendis Decembris], a comet in Aquarius and Pisces [♒ & ♓], lasting for 15 nights, appeared after sunset, stretching out its tail toward the east. Rochenb. and Prætorius.
4. In the year 1363 a huge comet appeared in the east for three whole months, casting its rays westward as far as the middle of the sky, with a dreadful burning of the air. Prætorius.
5. In the year of Christ 1471 or 1472, the comet that Regiomontanus observed is said to have constantly faced the stars of Gemini with its tail. At its first, morning appearance the tail stretched from east to west; at the end, when it was seen in the west in the evening after sunset, it cast its tail toward the west; in the middle of its duration, around midnight, it directed its tail from north to south. From this it can be clearly seen, if a globe is consulted, and the Sun's place, together with the comet's place, around the first appearance, on January 13 [Idibus Januarii], Old Style [St. V.], the Sun, that is, being at the beginning of Aquarius; the comet, however,

[Margin: Quando cauda alicujus Cometæ, ad ipſam Terram pertingere poſſit.] *When the tail of some comet may reach the Earth itself.*

[Margin: An Cometæ perpetuò caudas in certam Cœli plagam dirigant ?] *Whether comets always direct their tails toward a definite region of the heavens?*

[Margin: Ariſtotelicis, Cometæ cauda, inſtar flammæ eſt.] *To the Aristotelians, a comet's tail is like a flame.*

[Margin: Cometæ univerſi,in partem Soli adverſam, caudam projiciunt.] *All comets cast their tail toward the part opposite the Sun.*

[Margin: Vetuſtioribus quibusdam Cometis,probatur, in Solis oppoſitum projectas eſſe caudas.] *It is proved from certain older comets that tails are cast toward the point opposite the Sun.*

[Margin: Cometa Regiomontani ad easdem Stellas ſemper caudam direxit.] *The comet of Regiomontanus always directed its tail toward the same stars.*

situated around the stars of Virgo in Libra, is carefully noted; then again toward the end of February, the Sun being in Pisces and the comet in Aries, you will see that the tail thus continually faced Gemini; that is, that the comet cast its rays turned away from the Sun.

6. In the year after the birth of Christ 1491, around the feast of the Epiphany, a comet appeared at the beginning of Aries, with a head that was not large but a rather long tail; it followed the setting Sun, but stretched its

tail out behind it toward the east. The authority for this is Mechovius in the *Hist. Polon.* [Hiſt. Polon.] Still other examples of the kind occur here and there in the histories, from which it is abundantly understood, if in a rougher way, that the tails were stretched out toward the region of the heavens turned away from the Sun. I would readily grant, however, that there were some in the ancient age, for instance Hippocrates of Chios [Hippocratem Chium] and Aeschylus [Æſchylum], as is clear from Book I, Chapter 6 of Aristotle's *Meteorologica* [Meteorolog.], to whom even at that time this very thing was in some way apparent. But Aristotle at once crushed that opinion in the bud, as diametrically opposed to his own doctrine.

The most learned Petrus Appianus, however, as is clear from his Imperial Mathematical [work] [Mathematico Cæſareo], was the first of all to notice quite precisely, and to demonstrate clearly — and that from five haired stars, of the years 1531, 1532, 1533, 1538 and 1539 — that the tails pass through the comet's head toward the point opposite the Sun, and that the Sun, the tail and the comet's head thus always proceed under one and the same great circle. From this, as he himself admits, he was led to the opinion that the tails draw their origin solely from the Sun itself; for he says: *so that from this* (namely, that the tails are cast toward the part opposite the Sun) *I have been freed from all doubt; indeed, I have been compelled, even against my will, to believe that the tail must arise from the Sun.* Girolamo Fracastoro [Hieronymus Fracaſtorius] also detected this very thing in the three earlier comets, as he himself reports in Chapter 23 of the *Homocent.*: *In passing, however, we shall not keep silent about one thing that was common to these three comets and is, I think, worth reporting: all of them always cast their coma, or beard, directly toward the part opposite the Sun, so that if the Sun had been on the equinoctial toward the east, the beard stretched out along the equinoctial toward the west; and as far as the Sun had turned aside to one side, so far did that beard itself always turn to the opposite side. The comet that appeared in the year 1472 is also read to have done this.*

Likewise Gemma and Cornelius Frisius [Gemma & Cornelius Friſius] noted this very thing in eight subsequent comets from the year 1532, as can be read in Chapter 19 of *De radio Astronomico* [de radio Aſtronomico], and above all in Chapter 82 of *De Astrolabio Cathol.* [de Aſtrolabio Cathol.]: *But then* (says Gemma) *that fiery train is not drawn out according to the comet's place, but nearly* (as we at least have observed up to now, over 20 years, and as has been handed down by Petrus Appianus, a most learned mathematician, *is stretched out from the comet's head straight from the Sun, toward the opposite part.* Likewise Cornelius Gemma, in his little book on the appearance and nature of the comet of the year 1577, Chapter II; and no less in Book I, Chapter IV of *De naturae divinis characterismis* [de naturæ divinis characteriſmis], p. 117: *We are strongly driven to this by one inseparable property, confirmed by the testimony of many (especially of [my] father and of Appianus): that the tails of comets are always cast toward the part opposite the Sun. This would by no means happen if it were burning up like fire in*

tinder, since we all acknowledge that the nature of fire is to rise into a pyramid, with its base toward the matter and its cone set toward the starting-point of the kindling.

[Margin: Appianus primus omnium Caudæ directionem deprehendit, ac demonſtravit.] *Appianus was the first of all to detect and demonstrate the direction of the tail.*

[Margin: Fracaſtorii teſtimonium.] *The testimony of Fracastoro.*

[Margin: Gemmæ &Cornelii Friſiorum obſervationes de caudæ directione.] *The observations of Gemma and Cornelius Frisius on the direction of the tail.*

Many other most distinguished men have also held and confirmed the same opinion on the direction of comets: above all Cardano, in Book IV, *de luce & lumine*; Julius Scaliger, *Exercit.* 79, *de Comet.*; Mästlin [Mœſtlinus], on the comet of the year 1580; Josephus Blancanus [Joſephus Blancanus], Book XVI, Chapter 2, *de Sphærâ*; Giordano Bruno [Jordanus Brunus], Chapter XIX, *de Universis* [de Univerſis]; Mersennus [Merſennus] on Genesis, Chapter I, verse VIII, article 4; Fortunio Liceti [Fortunius Lycetus], *On New Stars and Comets*, Book II, Chapter 70, and Book IV, Chapter 17, and also Chapter XIII of *de lucidis in sublimi* [de lucidis in ſublimi]; Paulus Fabricius, Imperial Mathematician [Mathem.Cæſar.], in the Judgement on the comet of the year 1577; Squarcialupus, on the comet of 1577, p. 54; Tommaso Campanella, in his *Philos.* [Philoſ.] *realis*, Chapter VII, article 7; Snellius, on the comet of the year 1618, Chapter V; Christoph Rothmann [Chriſtophorus Rothmannus], on the same comet, in the Proem and Chapter VII; Thomas Fienus, on the comet of the year 1618, p. 47; Fromondus, on the same comet, Chapter VI, and also in Book III of the *Meteorol.*, Chapter 4, article 1; P. Gassendi [P. Gaſſendus], in the *Philos. Epic.* [Philoſ. Epic.], p. 1156; Franciscus Resta à Talleocotio [Franciſcus Reſta à Talleocotio], Book I, Chapter V of the *Meteorol.*; D. Habrecht, p. 30, in the description of the comet of the year 1618; Longomontanus, in the Appendix to the *Astron. Danic.* [Aſtron. Danic.], Chapter VI; Kepler [Keplerus], in the *Physiol. Com.* [Phyſiol. Com.], p. 101, and also in the Optical Part, Chapter VI, no. 13; P. Crüger [P. Crügerus], in the *Prodromus* and the *Uranodromus Cometicus*, Chapters VII and X; Wendelen [Wendelinus], in the *Teratolog. Com.*, pp. 13, 14, 15 and 20; Cysat [Cyſatus], Chapter IV, proposition 2; Laur. Eichstadius [Laur. Eichſtadius], in the *Exercit. Astron.* [Exercit. Aſtron.], thesis II — to say nothing of countless others. Some of them, however, lean toward the view that [comets] do not always cast their hair exactly toward the part opposite the Sun, but sometimes only approximately; so that this extension must be taken with a certain declination and inclination, as will be said more fully a little later. Meanwhile all agree on this: that comets always stretch out their tails nearly toward the region opposite the Sun. Above all, the most celebrated Tycho clearly perceived this very thing in 5 comets, as is evident from the letter to the Prince of Hesse [Principem Haſſiæ], written on the occasion of the comet of the year 1590: *It directed its tail, which was very thin and rather sparse, exactly toward the parts opposite the Sun, for as long as it could be noticed. Again: from the extensions of the tail that we have indicated, however, it is plainly gathered that it was everywhere turned exactly away from the Sun, provided*

only that the positions of the Sun are compared with the places of the comet's head which they held at the same times. He corroborates this very point in Book I of the *Progymnasmata* [Progymn.], p. 651.

In Book II, chapter VII, it is true, he thinks that the comet of the year 1577 cast its tail not altogether exactly toward the part opposite the Sun, but rather toward that of Venus; but he later changed that opinion. For he could by no means persuade even himself that Venus could supply so brilliant and powerful a light to comets, although he was still quite ignorant of the cause of this deviation from the straight path, as is clear from the letter written to Rothmann: *As for the drawing-out of the tail, I showed that in the comet of the year 1577 it constantly faced the star of Venus, although afterwards I rather inclined toward the parts of the Sun, because of some hidden optical reason, since it can scarcely be believed that the star of Venus shoots out such strong rays:* indeed, this is clear more fully from what follows, and also from p. 205 of the *Progymnasmata* [Progymnaſm.]. Therefore I have no doubt that Tycho too in the end understood very well that the tails of comets, not so much toward Venus's as toward the Sun's opposite

[Margin: Quinam præterea inter Autores huic ſententiæ ſubſcribant.] *Which other authors also subscribe to this opinion.*

[Margin: Nonnulli non omninò in directum à Sole; ſed cum certâ quâdam inclinatione, & declinatione caudas vergere ſtatuunt.] *Some hold that the tails point not altogether straight away from the Sun, but with a certain inclination and declination.*

[Margin: Tychonis hâc de re ſententia.] *Tycho's opinion on this matter.*

[Margin: Cometæ caudas minimè in adverſam Veneris partem projiciunt.] *Comets by no means cast their tails toward the part opposite Venus.*

parts, are stretched out, if you except that very slight deviation to which they are sometimes subject.

Furthermore, it is also beyond doubt that the comet of the year 1607 always directed its coma, too, straight toward the side opposite the Sun, as Longomontanus asserts in Chapter IX of *de novis Cœli Phænomenis*: *It also had* (he says) *a fairly long and dense tail, which the solar rays drove directly into the region opposite themselves, and that through the whole duration of the comet.* The same happened with the comet of the year 1618, on the testimony of Cysat, on the same [comet], Chapter V, proposition II, and Chapter VII, nos. 7 and 9, as he plainly deduces it by calculation: *From these things* (he says) *it is sufficiently demonstrated that the comet's tail was always turned straight away from the Sun and stretched out.* Others have likewise done this, namely: Peter Crüger, in the *Uranodromus Cometicus* [Uranodromo Comet.], chapter VII; Thomas Fienus, in the description of that comet, p. 47; D. Habrecht, p. 31; Joh. Dôlingius, Chapter VIII; Ambrosius Rhodius [Ambroſius Rhodius], Chapter II, *de Com.*; Gassendi, in the *Philos. Epicur. Meteorolog.* [Philoſ. Epicur.Meteorolog.], p. 1150; and also Wendelen, in the *Teratolog. Cometica* [Teratolog. Cometicâ].

But whether the comet of the year 1647 cast its hair toward the region opposite the Sun, let us now examine somewhat more deeply — and indeed

by the same method with which the same question will have to be examined for our own comet, where we have also undertaken to set out the foundations of the calculation at greater length. For now, however, to dispatch the matter briefly, we are content to set down only the bare calculation. At that time the comet was at about 8 degrees of Libra and at 26 degrees of northern latitude, and the Sun at 6° 30′ of Libra, [the comet] directing its tail not far from the left shoulder of Boötes, so that the place toward which the tail was stretched out is nearly at 10 degrees of Libra and at a northern latitude of 50°. From these data, once the calculation is correctly set up, each angle — namely H C D and D C G — becomes known from the next diagram, A; these must necessarily be equal if the coma is to be cast toward the part opposite the Sun.

The deviation of the comet, 1647 September 29, in the evening [Deviatio Cometæ Anno 1647 die 29 Septemb. veſperi.]

Right-angled triangle A F C [Triangulum Rectangulum A F C.]

6ˢ 8° 0′ — *Longitude of the comet's head*
6ˢ 6° 30′ — *Place of the Sun*
1° 30′ — AF — *Antilogarithm* — 34 — *Logarithm* 364287
26° 0′ — FC — *Antilogarithm* — 10670 *A.*
26° 2′ — CA — *Antilogarithm* — 10704 — *Logarithm* 82350 *S.*
281937 — *Logarithm* — ACF 3° 25′

Oblique-angled triangle C I D [Triangulum Obliquang. C I D.]

6ˢ 10° 0′ — *Longitude of the place to which the tail was stretched* — *Latitude* 50′ 0″ — *Bor. Capitis* 40° 0′ ID
6ˢ 8° 0′ — *Longitude of the head* — *Latitude* 26 0 — 64 0 IC
2° 0′ — CID — *Logarithm* 335528
40° 0′ — ID — *Logarithm* 44194 *A.* — *Antilogarithm* 26651
1° 17′ — DH — *Logarithm* 379722 — *Antilogarithm* 25 *S.*
Mesologarithm 379697 + — 26626 — *Antilogarithm* 39° 59′ HI
CH — *Logarithm* 89894 + *S.* — 64 0 IC
3° 9′ — HCD — *Mesologarithm* 289803 + — 24 1 CH
3° 25′ — ACF *or* ICG
0° 16′ — DCG — *A slight northern deviation*[561]

[Margin: Cometam 1607, caudam in partem Soli oppoſitam direxiſſe.] *That the comet of 1607 directed its tail toward the part opposite the Sun.*

[561] The calculation stands on the page without a ruled grid and is set here line by line, each figure in its printed order; the dashes stand for the printed spacing, not for printed marks. The page heads its left column of figures with S., a degree sign and a minute stroke (signs, degrees, minutes), and those values are given here in that notation. Printed rules stand under the Place of the Sun, under 10670 A., under 82350 S., under the Longitude of the head, under 44194 A., under 25 S., under 89894 + S., under 64 0 IC (second instance) and under 3° 25′ ACF. A printed bracket joins the DH logarithm line and the mesologarithm line beneath it. The latitude of the place of the tail is printed as 50′ 0″, with a prime and a double prime, where the prose above gives it as 50°; the figures 26 0, 64 0 and 24 1 are printed without marks.

[Margin: Quam Pl[[a/ă]]gam versùs Cometa 1647 Comam expoſuerit.] *Toward which region the comet of 1647 set out its coma.*

[Margin: Calculus pro deviatione Cometæ.] *Calculation for the comet's deviation.*

It is therefore clear that the tail deviated from that straight line drawn from the Sun through the comet by only 16′. Just as this deviation is of no consequence, so we may rightly state that this comet directed its tail toward the point opposite the Sun, which is what was to be investigated.

And so I am thoroughly convinced that not only those comets from the year 1531 onward, but also all the others that have ever blazed, stretched their tails toward the opposition of the Sun; and had our predecessors noted this more carefully, the matter would long since have been placed quite beyond all hazard of doubt. That this is truly so, however, the comet of the year 1652 also clearly shows: through its whole duration it displayed, no less, a mane turned nearly away from the Sun, except that it sometimes deviated a very little from that straight path drawn through the Sun and the comet. What the cause of this phenomenon was, which appeared both in this comet and in certain others, it is not yet permitted to investigate here; it must be deferred to a more suitable occasion.

Let us now take up the calculation itself, and examine with the greatest care what the direction was at different times. In the diagrams set beside this, then, let A F E B be the semicircle of the ecliptic, A the Sun, B the point opposite it, I the pole of the ecliptic, C the comet, D the fixed star, or [that] of the point of the heavens to which the comet's tail was stretched;

Diagram. One engraved block of four diagrams, set between the two parts of the paragraph, each with a large diagram letter: A (upper left), B (upper right), C (lower left) and D (lower right). Each shows a great circle running from A, marked with a symbol of the Sun, to B, with two arcs drawn down from a pole I to F and E; C, H and D are marked where the arcs meet the circle, D with a star in B, C and D, and a dotted line joins H and D in B, C and D. Three diagrams carry a dated caption in italic script. The engraver's signature stands at the lower right.

- A (upper left, at the Sun symbol, left end of the base arc): A
- A (below the base arc, left end): F, E
- A (right end of the base arc): B
- A (on the arcs near the left end): C, H, D, G
- A (top of the two arcs): I
- A (centre): A, the diagram letter
- B (top, caption): *Ad Diem 20 Decemb.* "For the day, 20 December"
- B (top of the line through the caption): L
- B (at the Sun symbol, left end of the upper arc): A
- B (along the upper arc): G, F, E
- B (right end of the upper arc): B
- B (centre): B, the diagram letter

- B (at the meeting of the lines, lower right): H, C, D (with a star)
- B (lower ends of two lines): I, M
- C (top, caption): *Ad Diem 26.27.30. Decemb.* "For the days, 26, 27, 30 December"
- C (top of the two arcs): I
- C (on the arcs): C, H, D (with a star)
- C (at the Sun symbol, left end): A
- C (centre): C, the diagram letter
- C (right end): B
- C (below the base arc): F, E
- D (top of the two arcs): I
- D (top, caption): *Ad Diem 3 Januarii.* "For the day, 3 January"
- D (on the arcs): C, D, H
- D (at the Sun symbol, left end): A
- D (centre): D, the diagram letter
- D (right end): B
- D (below the base arc): F, E
- D (lower right, signature): *Aut. [?]culps.* "the author engraved [it]"

I C F the quadrant of the circle of latitude drawn through the end of the tail, C D the whole comet with the course of its tail, A C B the circle of distance drawn through the Sun and the comet's head, A C the distance of the comet's head from the Sun, whose complement is C B, B C F the angle of the circle of latitude and of the distance of the comet's head from the Sun, H C D the angle of the circle of latitude and of the course of the tail itself, and B C D the true deviation itself of the tail from the point opposite the Sun. Now if the tip of the coma, D, falls on the same circle A C B of distance drawn through the Sun and the comet's head, at the point opposite the Sun, B, then from all deviation from the straight

[Margin: Cauda à recto tramite nonni[[b/h]]il deflexit.] *The tail turned aside somewhat from the straight path.*

[Margin: Cometa anni 1652, caudam pariter in oppoſitum Solis, cùm quâdam tamen deviatione, projecit.] *The comet of the year 1652 likewise cast its tail toward the point opposite the Sun, though with a certain deviation.*

[Margin: Quâ ratione directio, & deviatio Caudæ inveſtigari debeat.] *How the direction and deviation of the tail are to be investigated.*

path the tail is free, but tends straight toward the point opposite the Sun. If, however, the course of the tail C D declines from that circle A C B toward one side or the other, some deviation is given. And it is found in this very easy way: namely, if both the angle B C F of the circle of latitude and of the distance of the comet's head from the Sun, and likewise the angle H C D of the circle of latitude and of the course of the tail itself, are investigated. If these are altogether equal, no deviation is present in the tail; but if they differ, the difference itself is the deviation B C D that was sought. So when the comet is in southern latitude and the angle H C D is found to be the greater, the tail

deviates toward the south; but when this angle is smaller than the other, B C F, it bends toward the north. Again, when the comet's latitude is northern and the angle H C D is the greater, the deviation is northern; conversely, if it is smaller, a southern deviation is given.

[Margin: Calculi Methodus.] *The method of the calculation.*

Now, to investigate these angles B C F (or its complement A C F, when needed) and H C D, or the deviation B C D itself, one must have at hand the place of the Sun, the longitude and latitude of the comet's head, and the longitude of that fixed star, or point, toward which the tip of the tail then points; otherwise it can in no way be done. 1. In the right-angled triangle B C F, therefore, let the side B C be investigated, or its complement A C, of the distance of the comet's head from the Sun. 2. From the difference of longitude of the Sun and of the comet's head, A F, or its complement F C, and from F C, the comet's latitude, [find] the angle B C F. 3. From the difference of latitude of the comet's head and of the fixed star, or the angle C I D, and from the latter's latitude I D, [find] the side H I in the triangle I H D; from it let I C, the comet's latitude, be subtracted, and C H remains. 4. From the angle C I D and H I, let the perpendicular D H be sought. 5. From D H and C H the angle H C D is found; if the angle B C F found above is taken away from it, you will have the angle B C D, the deviation sought. Since this method of finding it is quicker than others, we have therefore also set out to investigate in this way the inclinations on all the days on which our comet was observed, beginning indeed from 20 December, the day on which the comet was first observed by us. It then stood (namely at 9^h 50^m) above Regel, while directing its tail through a certain star of Orion above the foot, in Eridanus, called the Hilt of the Sword [Manubrium Enſis], and toward the belt.

Before we come to that, however, the comet's longitude and latitude for the given time will have to be computed in the triangle G F C: namely from the comet's distance from the ecliptic, G C, or rather from the point of intersection of the orbit and the ecliptic, G — a distance to be drawn, indeed, from our table: 30° 39′ — and also from the angle F G C of the orbit and the ecliptic, which likewise became known already in Book I: 74° 6′. The longitude F is found thus: if G F is added to the point of intersection (or subtracted from it, according as the comet is given below or above the ecliptic). Here it should be noted that it makes very little difference whether you take the angle of the ecliptic and the orbit, and also the point of intersection, a minute or two greater or smaller. For there is no point in probing this so finely, since the observation itself was not made so accurately either. For who could have detected so exactly whether the star itself, through which the tail was stretched out, stood exactly in the very middle of the coma, especially since it then displayed a remarkable breadth?

Deviations of the comet's tail from the point opposite the Sun, in the year 1652 and 1653, December 20 [Deviationes Caudæ Cometæ ab oppoſito Solis, anno 1652 & 1653. Decembris XX.]

Right-angled triangle G F C, for the comet's longitude and latitude [Triangulum Rectang. G F C. pro longitudine & latitudine Cometæ.]

Logarithm of the hypotenuse — G C — 67375 — *Antilogarithm* — G C — 15048

Logarithm of the angle — F G C — 3901 *A.* — *Antilogarithm* — F C — 13738 *S.*

Logarithm of the latitude — F C — 71276 — 29° 21′ *of the comet* — *Antilogarithm* — F G — 1310 — 9° 15′ *add*

Point of intersection — 58 33

Longitude of the comet — F — 67 48

Right-angled triangle C F B [Triangulum Rectang. C F B.]

8^{s} 29° 49′ — *Longitude of the Sun*

2^{s} 7° 48′ — *Longitude of the comet's head*

6^{s} 22° 1′ — BF — *Antilogarithm* 7572 — *Logarithm* 98116

29° 21′ — FC — *Antilogarithm* 13738 *A.*

36° 6′ — CB — *Antilogarithm* 21310 — *Logarithm* 52900 *S.*

143° 54′ — AC — 45216 — 39° 31′ BCF

Oblique-angled triangle C I D [Triangulum Obliquang. C I D.]

2^{s} 10° 26′ — *Longitude of the star above the foot of Orion, in Eridanus* — *Latitude* 27° 54′ — *Complement* 62° 6′ ID

2^{s} 7° 48′ — *Longitude of the comet's head* — 29 21 — 60 39 IC

2° 38′ — CID — *Antilogarithm* + 106 — *Mesologarithm* + 307927

62° 6′ — ID — *Mesologarithm* — 63587 *A.*

62° 5′ — HI — *Mesologarithm* — 63481 — *Logarithm* + 12372 *A.*

60° 39′ — IC — *Mesologarithm* + 320299 — 2° 19′ DH

1° 26′ — CH — *Logarithm* + 368833 *S.*

Mesologarithm — 47534 — 58 8 HCD

39 31 BCF

Southern deviation — 18 37 BCD[562]

[Margin: Deviatio quæſita ad 20 Dec.] *The deviation sought, for 20 Dec.*

Since, therefore, the angle H C D is greater than the angle B C F, with the comet standing in the southern region, the tail certainly deviates from the point opposite the Sun, and indeed toward the South Pole, by 18° 37′, as is clearly evident from the preceding figure.

Let us now pass to the following observation, made on the 23rd at 7^{h} 22^{m}, when the comet was directing its tail toward the northern eye of Taurus. We shall dispatch its calculation more easily, because the data for this time are

[562] The calculation stands on the page without a ruled grid and is set here line by line, each figure in its printed order; the dashes between items stand for the printed spacing, and the dash printed before a mesologarithm or logarithm is the page's own minus sign, as is the + before others. The page heads the left column of figures with S., a degree sign and a minute stroke (signs, degrees, minutes), and those values are given here in that notation; figures printed without marks outside that column are kept bare. Printed rules stand under 3901, under 13738 S., under 58 33, under the Longitude of the comet's head (left column), under 13738 A., under 52900 S., under the second Longitude of the comet's head, under 63587 A., under 12372 A., under 60 39 (left column), under 368833 S. and under 39 31. As printed, 320299 and 368833 differ by 48534, where the page sets 47534.

already known to us from elsewhere, so that there is need to investigate only the angles B C F and H C D.

Right-angled triangle C F B [Triangulum Rectang. C F B.]

9ˢ 2° 44′ — *Longitude of the Sun*

1ˢ 28° 56′ — *Longitude of the comet's head*

6ˢ 33° 48′ — BF — *Antilogarithm* 18514 — *Logarithm* 58645

3° 0′ — FC — *Antilogarithm* 137 *A.*

33° 55′ — CB — *Antilogarithm* 18651 — *Logarithm* 58342 *S.*

146° 5′ — AC — 303 — *Logarithm* 85° 32′ BCF

Oblique-angled triangle C I D [Triangulum Obliquang. C I D.]

2ˢ 3° 37′ — *Longitude of the star in the northern eye of* ♉ *[Taurus]* — *Latitude* 2° 37′ *A.* — *Complement* 87° 23′ ID

1ˢ 28° 56′ — *Longitude of the comet's head* — 3 0 — 87 0 IC

4° 41′ — CID — *Antilogarithm* + 334 — *Mesologarithm* + 250199

87° 23′ — ID — *Mesologarithm* — 308563 *A.*

87° 22½′ — HI — *Mesologarithm* — 308229 — *Logarithm* + 106 *A.*

87° 0′ — IC — *Mesologarithm* + 250305 DH

0° 22½′ — CH — *Logarithm* — 502906 *S.*

Mesologarithm — 252601 — 85° 26′ HCD

85 32 BCF

Northern deviation — 0 6 BCD[563]

[Margin: Calculus deviationis ad d. 23 Decemb.] *Calculation of the deviation for the day 23 December.*

From this calculation it is abundantly clear — since the angles are nearly equal to each other, except for a very few seconds — that the comet cast its tail quite exactly toward the region opposite the Sun on this occasion too. I would like you to note this well, especially because at the same time the comet stood no more than 3 degrees from the ecliptic toward the south. For in its proper place this will give us occasion to raise an entirely new question about the inclination of the tail.

[Margin: Quanta fuerit deviatio die 23 Decembr.] *How great the deviation was on 23 December.*

For 26 December, at 9ʰ 50ᵐ in the evening [Ad diem 26 Decembr. Hor. 9 50′ veſp.]

With the comet standing in nearly the same straight line with two little stars in the foot of Perseus, or rather ⅓ degree above them, and stretching out its tail toward about the Heel of Perseus.

Right-angled triangle C F B [Triangulum Rectang. C F B.]

9ˢ 5° 54′ — *Longitude of the Sun*

[563] Set as the calculation above. Printed rules stand under the second Longitude of the comet's head (left column), under 137 A., under 58342 S., under the Longitude of the comet's head of the oblique triangle (left column), under 308563 A., under 106 A., under 502906 S. and under 85 32. The page sets the difference of the two longitudes as 6 33 48, with 33 in the degrees place of the signs column, that is 213° 48′ without carrying a sign.

1ˢ 24° 34′ — *Longitude of the comet's head*
6ˢ 41° 20′ — BF — *Antilogarithm* 28651 — *Logarithm* 41485
13° 20′ — FC — *Antilogarithm* 2732 *A.*
43° 4′ — CB — *Antilogarithm* 31383 — *Logarithm* 38158 *S.*
136° 56′ — AC — 3327 — *Logarithm* — 75° 18′ BCF

Oblique-angled triangle C I D [Triangulum Obliquang. C I D.]

1ˢ 26° 17′ — *Longitude of the point ⅓ degree above the Heel of Perseus* — *Latitude* 12° 28′ *B.* — *Complement* 77° 32′ ID
1ˢ 24° 34′ — *Longitude of the comet's head* — *Latitude* 13 20 — 76 40 IC
1° 43′ — CID — *Antilogarithm* + 45 — *Mesologarithm* + 350754
77° 32′ — ID — *Mesologarithm* — 150921 *A.*
77° 32′ — HI — *Mesologarithm* — 150876 — *Logarithm* + 2386 *A.*
76° 40′ — IC — *Mesologarithm* + 353140 DH
0° 52′ — CH — *Logarithm* + 419136 *S.*
Mesologarithm — 65996 — 62° 40′ HCD
75 18 BCF
Southern deviation — 12 38 BCD[564]

Since, therefore, in this observation the latter angle, B C F, is greater than the former, and the comet stood above the ecliptic in the northern region of the sky, it is clearly evident that the coma was cast not altogether precisely toward the point opposite the Sun, but with a certain deviation — namely 12 degrees and 38′ — toward the south.

[Margin: Projectio Caudæ ad diem 26 Decembr.] *The projection of the tail for 26 December.*

For 27 December, at 6ʰ 54ᵐ in the evening [Ad diem 27 Decemb. hor. 6 54′ veſp.]

When the comet was casting its tail between the left leg of Perseus and the two [stars] in his foot, as our fifth observation attests.

Right-angled triangle C F B [Triangulum Rectang. C F B.]

9ˢ 6° 48′ — *Longitude of the Sun*
1ˢ 23° 33′ — *Longitude of the comet's head*
6ˢ 43° 15′ — BF — *Antilogarithm* 31694 — *Logarithm* 37807
16° 30′ — FC — *Antilogarithm* 4205 *A.*
45° 42′ — CB — *Antilogarithm* 35899 — *Logarithm* 33450 *S.*

[564] Set as the calculations on the preceding page: line by line, each figure in its printed order, the dashes between items standing for the printed spacing; the dash printed before a mesologarithm or logarithm is the page's own minus sign, as is the + before others. The left column is headed S., a degree sign and a minute stroke (signs, degrees, minutes) and its values are given in that notation; figures printed without marks outside that column are kept bare. The page sets the difference of the two longitudes as 6 41 20, with 41 in the degrees place of the signs column, that is 221° 20′. Printed rules stand under the Longitude of the comet's head (left column), under 2732, under 43 4, under 38158 S., under the Longitude of the comet's head of the oblique triangle (left column), under 150921 A., under 2386 A., under 76 40 (left column), under 419136 S. and under 75 18.

134° 18′ — AC — 4357 — *Logarithm* — 73° 12′ BCF[565]

Oblique-angled triangle C I D [Triangulum Obliquang. C I D.]

1ˢ 28° 30′ — *Longitude* — *Latitude B.* 14° 0′ — *Complement* 76° 0′ ID

1ˢ 23° 33′ — *Longitude of the comet's head* — *Latitude B.* 16 30 — 73 30 IC

4° 57′ — CID — *Antilogarithm* + 374 — *Mesologarithm* + 244635

76° 0′ — ID — *Mesologarithm* — 138899 *A.*

75° 57′ — HI — *Mesologarithm* — 138525 — *Logarithm* + 3037 *A.*

73° 30′ — IC — *Mesologarithm* + 247672

2° 27′ — CH — *Logarithm* + 315244 *S.*

Mesologarithm 67572 — 63° 2′ HCD

73 12 B CF

Southern deviation — 10 10 B CD[566]

On this day too the coma inclined toward the same region, and toward the ecliptic, since the difference of the angles found is nearly as great as on the preceding day; so that it deviated somewhat toward the south from the straight path and from that great circle drawn through the Sun and the comet's head.

[Margin: Die 27 Dec. Protenſio Caudæ Auſtralis extitit.] *On 27 Dec. the extension of the tail was southern.*

For 30 December, at 6^{h} 10^{m} 30^{s} in the evening [Ad diem 30 Decembr., hor. 6 10′ 30″ veſp.]

When it was directing its rather short and very sparse tail toward the left knee of Perseus.

Right-angled triangle C F B [Triangulum Rectang. C F B.]

9ˢ 9° 50′ — *Longitude of the Sun*

1ˢ 21° 28′ — *Longitude of the comet's head*

6ˢ 48° 22′ — BF — *Antilogarithm* 40893 — *Logarithm* 29114

23° 23′ — FC — *Antilogarithm* 8570 *A.*

52° 26′ — CB — *Antilogarithm* 49463 — *Logarithm* 23248 *S.*

127° 34′ — AC — *Logarithm* 5866 — 70° 34′ BCF

Oblique-angled triangle C I D [Triangulum Obliquang. C I D.]

2ˢ 0° 52′ — *Longitude of the star in the left knee of Perseus* — *Latitude B.* 19° 4′ — *Complement* 70° 56′ ID

1ˢ 21° 28′ — *Longitude of the comet's head* — 23 23 — 66 37 IC

9° 24′ — CID — *Antilogarithm* + 1352 — *Mesologarithm* + 179849

70° 56′ — ID — *Mesologarithm* — 106239 *A.*

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[565] Set as the calculation above. The page sets the difference of the two longitudes as 6 43 15, with 43 in the degrees place of the signs column, that is 223° 15′. Printed rules stand under the Longitude of the comet's head (left column), under 4205, under 45 42 (left column) and under 33450 S. The oblique-angled triangle for this day stands on the following page.

[566] Set as the calculations on the preceding pages. This is the oblique-angled triangle of the calculation for 27 December begun on the preceding page. The label of the first longitude is the single word *Long.*, with no star named. No sign is printed before 67572. Printed rules stand under the Longitude of the comet's head (left column), under 138899 A., under 3037 A., under 73 30 (left column), under 315244 S. and under 73 12.

70° 42′ — HI — *Mesologarithm* — 104887 — *Logarithm* + 5784 *A.*
66° 37′ — IC — *Mesologarithm* + 185633 DH
4° 5′ — CH — *Logarithm* + 264624
Mesologarithm — 78991 — 65° 35′ HCD
70 34 BCF
Southern deviation — 4 59 BCD[567]

[Margin: Directio Caudæ ad 30 Decemb.] *The direction of the tail for 30 December.*

For 3 January, at 6^{h} 45^{m} in the evening, in the year 1653 [Ad diem 3. Januarii, hor. 6 45′ veſp. Anno 1653.]

With the comet casting its tail — fairly long, but rather sparse — toward the star of Perseus, namely the Bend of the left side.

Right-angled triangle C F B [Triangulum Rectang. C F B.]

9^{s} 13° 58′ — *Longitude of the Sun*
1^{s} 20° 11′ — *Longitude of the comet's head*
6^{s} 53° 47′ — BF — *Antilogarithm* 52621 — *Logarithm* 21469
29° 3′ — FC — *Antilogarithm* 13445 *A.*
58° 54′ — CB — *Antilogarithm* 66066 — *Logarithm* 15517 *S.* — *Logarithm* — 70° 26′ BCF[568]

Oblique-angled triangle [Triangulum Obliquang.]

1^{s} 29° 59′ — *Longitude of the star in the Bend of the side of Perseus* — *Latitude B.* 27° 14′ — *Complement* 62° 46′ ID
1^{s} 20° 11′ — *Longitude of the comet's head* — *Latitude B.* 29 3 — 60 57 IC
9° 48′ — CID — *Antilogarithm* + 1470 — *Mesologarithm* + 175602
62° 46′ — ID — *Mesologarithm* — 66424 *A.*
62° 25′ — HI — *Mesologarithm* — 64954 — *Logarithm* + 12066 *A.*
60° 57′ — IC — *Mesologarithm* + 187668 DH
1° 28′ — CH — *Logarithm* + 366534 *S.*
Mesologarithm — 178866 — 80° 30′ HCD
70 26 BCF

[567] Set as the calculations above. The page sets the difference of the two longitudes of the right-angled triangle as 6 48 22, with 48 in the degrees place of the signs column, that is 228° 22′. No letter is printed after 264624. Printed rules stand under the Longitude of the comet's head (left column), under 8570 A., under 52 26, under 23248 S., under the Longitude of the comet's head of the oblique triangle (left column), under 106239 A., under 5784 A., under 66 37, under 264624 and under 70 34.

[568] Set as the calculations above. The page sets the difference of the two longitudes as 6 53 47, with 53 in the degrees place of the signs column, that is 233° 47′. For this calculation the page prints no AC line and no remainder of the logarithms: the second *Log.* on the last line stands with no figure after it. Printed rules stand under the Longitude of the comet's head (left column) and under 13445 A. The oblique-angled triangle for this day stands on the following page.

Northern deviation — 10 4 BCD[569]

[Margin: Projectio Caudæ ad diem 3. Januarii.] *The projection of the tail for 3 January.*

We therefore think it has been shown clearly enough in which direction the tail of our comet was extended: namely, into the part turned nearly away from the Sun, but nevertheless with some inclination. And indeed at the beginning of the apparition, when the comet was moving below the ecliptic, in southern latitude, [it was extended] downward, as it were, with a southern deviation. On 23 December, however, the comet, being very close to the Sun's path, directed its hair quite precisely into the region opposite the Sun. Again, on 26, 27 and 30 December, when the comet had become northern and was moving above the ecliptic, the tail was likewise inclined downward, but toward the ecliptic, toward the south. On 3 January, however, it bent its tail entirely the opposite way, toward the north, upward, away from the ecliptic.

[Margin: Quâ ratione Cometa 1652 deviaverit à lineâ rectâ per Solem & Cometam ductâ.] *How the comet of 1652 deviated from the straight line drawn through the Sun and the comet.*

And so it is certain, from this comet too, not only that the tails are cast into the part turned away from the Sun, at times with some deviation from the straight path, but also that they draw all their light from the Sun, as the heads of comets do. But by what means the tails of comets are produced, in general, from the rays of the Sun; and how it comes about that the faces of the comae appear so widely different — now paler, now more blazing, now sparser, now denser, now tapered [recte: faſtigiatæ] to a point, now with rays dispersed and spread apart, and indeed sometimes with rays inclined and curved — this is what we must now go on to discuss. It is also very nearly the chief thing that has to be said, and the thing that has tormented the minds of philosophers most of all up to now, as is gathered more than sufficiently from the so varied opinions of most distinguished men. It will help not a little, for the sake of better understanding, to append these opinions here, partly in brief.

[Margin: Caudæ Cometarum univerſæ lumen à Sole hauriunt.] *The tails of comets, all of them, draw their light from the Sun.*

[Margin: Inquirendum potiſſimum eſt, quâ ratione Caudæ, & unde tam diverſimodæ procreentur.] *It must above all be investigated by what means tails are produced, and from what source they come to be of such diverse kinds.*

1. The opinion of Aristotle and of all the Peripatetics, which has been spread most eagerly in the Schools until now, is this: that the coma of comets is a flame and an exhalation kindled in matter rarer than that of the head;

[569] Set as the calculations of the preceding pages: each line gives, as printed, the left column of signs, degrees and minutes, the point letters, and the logarithmic and angular figures with their signs. The heading prints no point letters. The second latitude is printed 29 3 without degree and minute marks. Printed rules stand under the Longitude of the comet's head (left column), under 66424 A., under 12066 A., under 60 57 (left column), under 366534 S. and under 70 26.

and that, according to the different matter destined as fuel for this flame, it takes on different faces and shapes of tail, or of hair. They hold, besides, that this flame is always driven in one direction by the wind, or is pushed by the Sun into the opposite part, and is carried upward by its natural lightness — as some of them maintain, but wrongly.

[Margin: Peripateticorum de caudis Cometarum opinio.] *The opinion of the Peripatetics on the tails of comets.*

2. Seneca thinks that the tail of comets is the rays of the body itself, and light which the comets themselves shoot out by a certain natural force, as may be seen in Book VII of the *Natural Questions*, chapter 26. Rothmann agreed with him in nearly the same way — at the beginning, that is, before he took up Tycho's opinion — as may be seen from his letter to Tycho dated 1588 September 19 [1588, 13 Calend. Octob.]: "The tails," he says, "of the same

[Margin: Sententia Senecæ & Rothmanni.] *The view of Seneca and Rothmann.*

matter as the head are [they], and [they] appear in the same way as the head, through illumination: this is also evident from the fact that the head of the comet, at its disappearance, appears dispersed in the same way as the tail." Mastrius [Mastri] and Bellutus [Belluto] also held this opinion, it seems, in Disputation 4 *On the Heavens*: namely, that the head and the tail shine with their own light.

3. Gemma Frisius, in the *Astrolabium Catholicum*, chapter 82, says that the tail is a fire kindled from a simple and wholly celestial body, namely the head of the comet, and kindled indeed by the Sun, and driven by the Sun's violent action into the opposite region.

[Margin: Gemmæ Frifii.] *Of Gemma Frisius.*

4. Others hold that the tails of comets are rays of the Sun passed through the semi-transparent head, which is dark in itself, as through a glass globe. This view, as is clear from the *Astronomicum Caesareum*, also pleased Peter Apian. Cardanus too subscribes to it, in Book 4 of *On Subtlety*: *that the comet* (namely) *is a globe set in the heaven, which appears illuminated by the Sun, and while the rays pass through, they form the likeness of a beard or of a tail.* Julius Scaliger, Exercitation 79, adds: *For the comet is a body both so dense that it can be illuminated, and so rare that it can transmit rays, which we also see in a glass globe. But that it is not in the region of vapours is false. That it is in the heaven is far further from the truth.* Likewise Thomas Fienus, in his description of the comet of the year 1618: *The tail* (he says) *is not a part of the comet, nor is it a substance or a* [Greek: σύστασις (systasis, "a standing-together, a composite body")], *but only an* [Greek: ἔμφασις (emphasis, "an appearance")], *and a certain splendour of the light of the Sun diffused through the comet into the part opposite the Sun; such as is noticed with the rays of the Sun entering a bedroom through a window.* Page 44.

[Margin: Appiani & Cardani.] *Of Apian and Cardanus.*

[Margin: Thomæ Fieni ſententia.] *The view of Thomas Fienus.*

Moreover, D. Habrecht thinks that the coma is the light of the Sun struck through the ethereal body of the comet into the part opposite the Sun, but by no means a substantial body: in his description of the comet of the year 1618, pages 116 and 117. So very many have been devoted to this view — namely Aversa, Telesius, Tassonus and others.

[Margin: Habrechti.] *Of Habrecht.*

5. Tycho Brahe holds that the outflow of the tail is rays penetrating the head of the comet and terminated in some matter that is not entirely transparent; for he supposes that the substance of the aether is not wholly diaphanous. Josephus Blancanus [Giuseppe Biancani], in his *Cosmographia*, Book XVI, Chapter II, is not far from this view, saying: *They think that the cause of this* (namely, of the beard of comets) *is the brightness of the Sun, falling upon the body of the comet and darting out from there into the opposite part: just as we also see a glass ball set out in the Sun so unite and transmit the Sun's light passing through it into the part turned away from the Sun that it not only appears, but even burns.* Likewise Ericus Puteanus [Erycius Puteanus], in the *Paradoxologia*, Paradox 9, holds nearly the same: *The globe of the comet is illuminated by celestial light. The radiance penetrates, and transmits its force broken in a certain way. Thus we observe by experience that the force of light goes forward, but blunted, whenever it is received by a pellucid body: it is neither retained whole nor transmitted. An example, as they would have it, is also from the Sun, which, if it falls upon a flame, will darken its rays. The comet, however, has neither matter so rare that the splendour of the Sun could pass through it without hindrance, nor so dense that it would reflect the radiance it receives.* So he says.

[Margin: Tychonis Brahæi.] *Of Tycho Brahe.*

[Margin: Blancani.] *Of Blancanus.*

[Margin: Puteani.] *Of Puteanus.*

6. Kepler, in the *Optical Part of Astronomy*, Chapter VI, no. 13, laboured with the utmost effort to save the tails of comets in two different ways; but

[Margin: Kepleri ſententia prior.] *Kepler's earlier view.*

he could not yet extricate himself completely from everything, seeing very well that not even in this way could all the appearances concerning comae be demonstrated, since various doubts presented themselves. First he says: *Why do the tails not face precisely the point opposite the Sun? 2. Why do they almost always decline; why are they curved into an arc? And finally, what is that which receives the Sun's ray and, struck by it, shines back, showing the figure of a tail? For if you say it is matter, pertaining to the essence of matter, you will have fashioned a most monstrous monster. If* [you say it is] *the ethereal air, I ask why it is not illuminated by the Sun in this way every day, so as to shine even without a comet.* Nevertheless he maintains that *it can be illuminated by the light of the Sun passing through the body of the comet, because through the body of the comet — which for this reason ought to be purely pellucid, and very dense — the rays of the Sun are concentrated*

and doubled, and also coloured. But if we shall not be permitted to claim for the tail of comets a matter of its own, we shall be forced to say that the ethereal air itself is not entirely without matter, but is fit to be painted so strongly, from so near a place, by the coloured ray of the Sun passing through the body of the comet, that with this colour, or splendour, it can bend into the eyes at a distance.

[Margin: Dubia quædam circa caudas occurrentia.] *Certain doubts that arise concerning tails.*

Secondly, however, he thinks that the comet truly breathes out some lucid matter from its head, and indeed into the region where the solar rays break through. He kept this opinion in his *Physiology of Comets* [Cometarum Phyſiologiâ] too, pages 100 and 101, and set it out clearly there, as is evident from what follows: *The matter having been gathered into a globe, from the nature of all things that are united, and the Sun, with straight rays, striking and penetrating this pellucid globe, I think that something of the innermost matter of the comet always goes out by the same path by which the rays of the Sun break through; and that in this way the body of the comet is polluted, coloured, worn away, and finally annihilated; and that, just as silkworms* [are consumed] *by spinning out thread, so comets are consumed by breathing out their tail, and finally die.* And a little later: *But why I should have said that something is continually expelled from the matter of the comet's body by the rays of the Sun, along the path of the Sun's rays — the reason was given me by the comet's tail, of which it is established that it always extends very nearly into the region turned away from the Sun, and is thus formed by the rays of the Sun. Yet it is impossible that the rays of the Sun should be seen in the pure ethereal air that is behind the comet* [and] *not be seen in the* [air] *immediately surrounding it, unless there is some matter behind the comet into which the rays of the Sun, passing through the comet, strike. For not even among us can a ray of the Sun be seen except in matter that receives the ray of the Sun — for example on walls, clothes, the surfaces of waters, the earth, mountains, clouds, or in thick air.* So he says.

[Margin: Cometas materiam quandam lucidam ex corpore [?]uo exhalare Keplerus autumat.] *Kepler maintains that comets exhale some lucid matter from their [?] body.*

[Margin: In purâ aurâ æthereâ radii Solis non ſiſtuntur.] *In the pure ethereal air the rays of the Sun are not stopped.*

Others besides defend this view: namely Snellius, on the comet of the year 1618; P. Crüger, *Uranodromus*, chapter 18; and also Longomontanus, chapter VI of *On the New Phenomena of the Heaven*, where he says: *Two things concur in producing and forming the hair, or tail, of the comet: namely the solar rays (perhaps also those of the other stars, which mingle themselves with the solar ones) and the matter around the body of the comet, or of which it consists. While these solar rays act upon it powerfully, indeed almost violently, and lick its surface and wear it away, it happens that its lighter particles, and those most ready to follow, are snatched away by those rays and, as far as can be done, are projected continuously across the space outside the rest of the comet's body into the parts opposite the Sun; yet in such a way*

that they do not wholly desert the head of the comet, from which they take their origin, or vanish in the aether, unless gradually worn away and consumed by the solar rays.

[Margin: Snellius & Crügerus Keplero adſtipulantur.] *Snellius and Crüger agree with Kepler.*

No less does P. Gassendi favour this same opinion in the *Philosoph. Epicur.*, page 1159, in the *Meteorol.*: namely, that the tail consists from its rise onward of the same matter as the head itself, except that it differs in rarity and thinness; and that this same, rarer matter is expelled by the force of the solar rays into the part turned directly away from the Sun.

[Margin: Gaſſendi ſententia de materiâ caudæ.] *Gassendi's view on the matter of the tail.*

Nor is this opinion displeasing to Camillus Gloriosus, Book 3, chapter 8, *On Comets*: namely, that because a certain matter from the head can by no means be penetrated by the force of the rays, the comet then appears without tail and hair. Franciscus Resta too, because he could by no means extricate himself otherwise, embraced this same view, in the *Meteorol.*, chapter V, on comets: namely, that the solar rays expel the thin parts of the comet into the opposite region; and that when this matter is narrower around the head, the tail spreads out at its end, but when it is wider, the tail is drawn together at its extremity.

[Margin: Camilli Glorioſi, & Franeiſci Reſtæ.] *Of Camillus Gloriosus and Franciscus Resta.*

7. Fromondus, *On the Comet of the Year 1618*, Chapter VI, pages 116 and 117, thinks somewhat differently about the tails of comets. *That beard*, he says, *was most plainly solar rays struck through the head of the comet, and there, because of the density of the matter, refracted and then scattered into a beard. Therefore I say that, even if the beard was not scattered most directly away from the Sun, it was nevertheless rays of the Sun, not of any other wandering star or fixed star, which, wedged together, were vomited through the comet's occiput out of its chin, or mouth. But that this sometimes happens not in a straight line is owing to the varied refraction of the rays in the comet's brain, so to speak. For the substance of the comet's head is not of uniform density or opacity, and* [the rays] *cannot be scattered out equally through any part of the circumference whatever. For it gapes in places with certain cracks, as it were, which a rarer matter fills; by this way the rays pass through more easily than where it thickens itself. And hence it is that the lines of the rays sometimes appear divided; and these can perhaps also leap out from the centre in a circle, this way and that, and boil up again, so as to crown the circumference of the head.* This view he defends at greater length too in the *Meteorol.*, Book III, chapter IV, articles 1 and 2; where, however, he denies that the solar rays can be terminated in the purest aether, and hence grants a certain density to the aether surrounding the comet's head, which, even if it is the slightest, is nevertheless sufficient to reflect that light thus far.

[Margin: Liberti Fromondi.] *Of Fromondus.*

[Margin: Cur radii Cometarum non ſemper in directum omninò vergant ?] *Why the rays of comets do not always point entirely straight.*

8. Liceti, however, rejects outright Kepler's opinion — namely, that the comet's tail is a substance drawn out of the head by the force of the Sun, and illuminated (as we read in Book II, chapter 80, *On New Stars and Comets*) — and puts forward another. Since he denies that the rays of the Sun are seen in the pure ethereal air, but [says] that they can be terminated only in a somewhat dense body, he therefore thinks that matter adheres to the comet's body, driven against it from outside and compacted there, or generated near the comet by the same cause that produced the comet. This matter is illuminated either by the head's own light or by the solar rays, and becomes visible only in the comet's shadow, that is, opposite the Sun — as he discusses more clearly in Book V, chapter 59. He supposes, moreover, that the head of the comet is a heap of many little stars, not adhering very tightly to one another, mixed with certain diaphanous interstices: *For the coma*, he says, *or beard, or tail of comets is nothing other than either the light of the Sun passing through the head of the comet, which has matter not so packed and condensed, and poured across into the region opposite the Sun, re-*

[Margin: Fortunii Lyceti opinio.] *Liceti's opinion.*

[Margin: Autor præfatus,caputCometæ ex plurimis Stellulis conſtare aſſerit.] *The author just mentioned asserts that the head of the comet consists of very many little stars.*

flected, and [that] *from a diaphanous* [medium] *having some density, whether it is simply transparent or pseudo-transparent. Or* [it is] *the light of the comet reflected from the same transparent* [medium]*; or else the proper light of the many little stars standing around the head of the new star, visible, because of their faintness, only in the shadow of the comet's denser head.*

9. Father Giovanni Battista Riccioli and Francesco Grimaldi, in the *Almagestum*, Part II, Book VIII, Sect. I, Chapter 25, put forward two different accounts, not altogether improbable, of how to save the tails and their appearances. But since they have settled nothing certain about the position of the tail, or coma, and about the place of comets — that is, whether comets move in the aether above the Moon or in the sublunary air — and have instead left that question, on which this whole business depends, still in doubt, they seem to conclude nothing certain on this point. First, then, they lay down: *That the tail belongs to the substance of the comet and shines with its own light, propagated from the head into the remaining part; but that the face of the comet's head turns toward the Sun, like a heliotrope, or as one face of a magnet turns toward one pole, and moves about the centre of the head in a slow rotation, in such a way that the more perfect part of the comet is turned toward the Sun, while the remaining part, following the same motion, is turned away from the Sun and has various shapes according to the different species of comets, from the very disposition and configuration of the matter.* To

this account (as Riccioli himself admits) *nothing stands in the way except the sudden vibration by which the tail of the comet of the year 1618 appeared at one moment short and soon afterwards long — unless you attribute that very thing to little clouds, or to fumes running in between.*

[Margin: Quâ ratione Ricciolus & Grimaldus apparentias caudarum ſalvare ſtudeant.] *By what reasoning Riccioli and Grimaldi try to save the appearances of the tails.*

[Margin: Sententia prior. Caudas nimirùm lucere luce propriâ.] *The first view: namely, that tails shine with their own light.*

10. Their other opinion, since it seems to be derived from Cysat's theory, we shall set aside a little longer, and first bring forward the views of the said Cysat. For just as he is the first, so far as I know, who directed the telescope at a comet — with success as happy as it was of the greatest benefit to astronomy — so too he aimed somewhat nearer the mark than all the predecessors whose opinions we have set out above, and who relied on observations made with the naked eye only. For just as these could not see and recognize the comet's head clearly enough without telescopes, so too they could in no way penetrate this matter. For when light is denied, who does not go astray in the darkest shadows? But Cysat, in the year 1618, clearly detected — as we recalled in Book VI — that the comet's head consisted of various and most diverse bodies, gradually and successively growing and shrinking and changing their place by a proper motion; and from this he became more certain that the tail is generated from solar rays reflected and refracted, as he explains his meaning at sufficient length in the description of the same comet, Chapter 7. For he asserts: *That the comet's coma was not a flame, but a radiant cone, or pyramid, of the Sun's rays transmitted in that form and figure through the comet's head; in much the same way as the Sun shines into a room in a radiant pyramid through any opening or through a convex glass lens, or as a luminous streak is often cast upward or downward through various clouds, when we say either that fiery darts are being hurled in the sky, or that heavenly rods are quivering, or that water is being drunk by the Sun. For since the comet's head is a heap of many stars, or of bodies partly opaque and partly transparent, a passage of the solar rays through the comet's head can take place in two ways. 1. By refraction, as a bright cone is cast through a convex glass set opposite the Sun. 2. By reflection; for since there are heaped together many bod-*

[Margin: Cyſatus hâc in parte aliquantò propiùs ad metam collineavit.] *In this matter Cysat aimed somewhat nearer the mark.*

[Margin: Abſq; Teleſcopio Cometas rectè cognoſcere haud datur.] *Without a telescope it is not possible to recognize comets correctly.*

[Margin: CaputCometæ 1618,ex variis corporibus conflatum fuit.] *The head of the comet of 1618 was composed of various bodies.*

[Margin: Cyſati ſententia, de Cometæ caudâ.] *Cysat's view of the comet's tail.*

[Margin: Cauda Cometæ eſt trajectio radiorum Solarium.] *The comet's tail is a passage of solar rays.*

ies of irregular, varied shape in various ways, the Sun's rays, falling on them at various very obtuse angles and, as it were, merely grazing the surface of those bodies, go forward reflected almost in a straight line, with only a small bending, and produce the coma, or tail, of the comet. Nor does the objection long ago raised against Tycho seem to stand in the way: that the heaven is most subtle, and cannot make such rays visible even though it receives them. For the aether poured around the comet is not so subtle that the solar rays, gathered and intensified, cannot be terminated in it and be seen, while the rest of the aether is not seen.

[Margin: Materia caputCometæ circumſtans, habet ſuam denſitatem.] *The matter surrounding the comet's head has its own density.*

11. Riccioli and Grimaldi have more or less embraced this opinion. For they affirm, in the place cited above, that it is highly probable that the tail of comets is very fine and very numerous corpuscles (which, however, possess different degrees of density and opacity according to their distance from the comet's head) flying around the comet's head in the air or in the aether; but they make them much finer than [those] that meet the solar rays in a darkened room, or even than the twilight matter itself, the head with its coma being supposed to lie above the twilight sphere. These corpuscles, because of their greater distance from the Sun and their thinness and rarity, can by no means be seen by us through the reflected rays of the Sun, unless [the rays are] gathered into one by the force of refraction — though not in precisely the way in which they come together into one behind a glass sphere. And since they hold, with Cysat, that the head consists of various bodies that are by no means continuous and homogeneous, partly polyangular, partly spherical and spheroidal, it follows that by the help of these various surfaces the solar rays passing through the comet's head in different ways, both by refraction and by reflection, are collected in much greater numbers than if they did not pass through the comet's head, or were brought to us unrefracted. And in this way, [they hold,] tails appear to us, and gleam with a different aspect according to those most diverse corpuscles poured around the head, and according to the different shape of the head and of those bodies.

[Margin: Cui ſententiæ Ricciolus & Grimaldus ferè addicti ſunt.] *Riccioli and Grimaldi are more or less committed to this view.*

[Margin: Quâ ratione caudæ appareant.] *How tails appear.*

12. And these are the chief opinions of the philosophers on the tails of comets. Yet there are still others to be found who refer the production of the coma, or beard, to the mysteries of nature and to occult qualities, and who ascribe to a certain antipathy the fact that the tail always points to the side opposite the Sun. By that route, I admit, everything is indeed dispatched more readily; but since such views have little ingenuity or

learning in them, let us pass them over in silence: for in natural matters it is better, as far as can be done, to give one's effort to physical reasons.

[Margin: Nonnulli Philoſophi productionem caudæ ad occultas qualitates referunt.] *Some philosophers refer the production of the tail to occult qualities.*

Now the order of the work does seem to demand that, before we set out our own view on the tails of comets in full, we should duly examine each of the opinions brought forward, and show that they do not yet suffice to save the very many phenomena that present themselves concerning tails. But since it would be a very lengthy business to sift them all separately, and we would thus have to dwell on them far too long, let us on this occasion abstain from this labour entirely. For we have not decided to waste time on most tedious disputations, refuting and demolishing the opinions of others, and to show at length what the tails of comets are not; rather, we shall teach only what they are, from where they arise, and how, by means of our hypothesis, each and every appearance of comae, whatever has either appeared or can appear, may be happily explained and saved.

[Margin: Non omnium Philoſophorum contrarias opiniones refellere; ſed certam hypotheſin tradere, Autor conſtituit, quâ mediante omnium Cometarum Caudæ feliciter ſalvantur.] *The author has resolved not to refute the contrary opinions of all the philosophers, but to present a definite hypothesis, by means of which the tails of all comets are happily saved.*

But before we come to that, it will nevertheless be useful to consider somewhat more deeply in what, for the most part, the difference among these various opinions consists — in what, namely, they disagree, and in what they also nearly agree — and, besides, what the cause is why the phenomena of the tails cannot be derived entirely in that way. As for the first view — namely that of Aristotle and of all the Peripatetics, who refer all comets to the sublunary air, declare their matter to be burning and fiery, and hold them to be mere meteors — with them, I say, we have no business at all in this place, since we have already abundantly demonstrated the contrary at various points in this work: that comets are celestial bodies and move in the highest aether. The rejected opinions of all the others after Appianus, however, although they differ and disagree among themselves not a little, nevertheless agree entirely in this, as was also shown above: namely, that the tails of comets always point toward the region turned away from the Sun. This, too, is so very true that no one of sound mind can any longer call it into doubt in any way. But how the tails come into view, and from where they draw their light, is not entirely agreed among the philosophers. For some think that both the comae and the heads of comets shine with their own light, or that the tails are parts of the body and of the same substance, shining with their own light; others, again, think that the tails are nothing but solar rays passed through the comet's head.

[Margin: In quibus Philoſophorum variæ opiniones partim conveniant, partim diſcrepent.] *In what the various opinions of the philosophers partly agree and partly disagree.*

[Margin: Cur Peripateticorum opinio hoc loco ſilentio prætereatur ?] *Why is the opinion of the Peripatetics passed over in silence in this place?*

[Margin: Pleræq; Autorum opiniones in eo conveniunt; caudas in partes Soli oppoſitas projici.] *Most authors' opinions agree in this: that tails are projected into the parts opposite the Sun.*

[Margin: Potisſima quæſtio hæc eſt : quâ ratione caudæ ſub adſpectum cadant.] *The chief question is this: how tails come into view.*

The first opinion rightly deserves to be abandoned, and the other rather to be embraced, since by its help it is very difficult to deduce why the tails are constantly projected into the part opposite the Sun. By the second opinion, however, they try to demonstrate the tails in two ways. First, they suppose that the comet's head is transparent like a glass sphere, through which the rays are passed. Second, they grant (as is indeed actually the case) that the comet's head consists of various corpuscles, some opaque and some diaphanous, by means of which the solar rays passing through are partly refracted and partly reflected — and indeed in different ways, according to the constitution both of the opaque bodies and of the diaphanous parts mixed among them. But if we weigh the matter in an exact balance, we clearly find that on the first supposition — as through a glass globe — this business of explaining and deducing these various aspects and shapes of the comae by no means succeeds. For in that way the hair of comets would always come together into a sharp-pointed cone, and from then on they would shine only with pointed tails: which, however, is entirely contrary to experience. For a great many comets are seen with varied shape as regards the coma, and with scattered rays. But by means of the second view (which makes the heads of comets not altogether spherical but only disc-shaped, and composed of various bodies, partly round, partly angular), since it is easier [by it] to explain all the phenomena of the tails, it is rightly preferred to all the others. Nevertheless a difficulty of no common kind presents itself here: namely, how the rays are fixed and stopped in the region opposite the Sun? For in the purest and most subtle ethereal air light is not visible; rather, it must be terminated by some opaque body; otherwise those rays, passed through, escape all sight of the eyes, as optics demonstrates — just as not a few men

[Margin: Caudas non nativâ luce gaudere.] *Tails do not enjoy a native light.*

[Margin: Alii,corpus Cometæ, inſtar ſphæræ vitreæ, eſſe pellucidum fingunt.] *Others imagine the comet's body to be transparent like a glass sphere.*

[Margin: Per ſphæram vitream phænomena caudarum haud ſalvari.] *The phenomena of the tails are not saved by a glass sphere.*

[Margin: Quænam ſententia reliquis omnibus præferatur.] *Which view is preferred to all the others.*

[Margin: In puro æthere radii Solis non figuntur.] *In pure aether the rays of the Sun are not fixed.*

of learning have rightly recognized: namely Tycho, Kepler, Liceti, Fromondus and others.

For this reason Cysat too, who followed in Tycho's footsteps, laid down that the substance of the aether is not entirely diaphanous but has a certain density, so that it can receive and reflect the rays of the Sun. By this, certainly — as we cannot deny — that difficulty is in part relieved. But in truth Cysat merely asserts this, in Chapter VII, and by no means demonstrates it sufficiently: namely, that the aether is not entirely diaphanous but endowed with some density. We therefore reject that opinion outright, along with the others. And indeed chiefly for this reason, to say nothing of others: that in that case the solar rays would be seen in the aether at all times; and, moreover, the coma would be scattered continuously not only on the side of the comet turned away with respect to the Sun, but on every side. Hence something different necessarily lies hidden behind or around the comet: namely some rather dense matter, against which the rays of the Sun strike, and in which those rays, passing through the comet's head, refracted and reflected, are stopped and are seen.

[Margin: Ætherem quandam habere denſitatem Cyſatus non demonſtravit.] *Cysat has not demonstrated that the aether has a certain density.*

[Margin: Latet circa Cometam materia aliqua denſiuſcula.] *Some rather dense matter lies hidden around the comet.*

By this, too, I think, Kepler was led to hold that the solar rays passing through the heads of comets always carry with them something of the comet's innermost matter into the part opposite the Sun, in which those same solar rays would afterwards be stopped. But just as hardly anyone can grasp in his mind how this should come about, so, believe me, it is still much more difficult to demonstrate. Therefore this matter lying hidden behind the comet will have to be sought elsewhere. And this is indeed also the chief thing that comes up for consideration in tails — above all if it is to be not merely put forward but solidly demonstrated: namely, that matter of that kind adheres to comets, and also from where it takes its origin? Let us therefore now go and seek it out; but first let us set out our own view of where the origin of the tails lies, and how they come into view? Then let us also demonstrate all of this clearly with diagrams: that in this way the individual phenomena can be fittingly deduced and explained.

[Margin: Materia iſta poſt Cometam non ex ipſo corpore promanat.] *That matter behind the comet does not flow from the body itself.*

[Margin: Vnde materia illa Cometis adhærens exoriatur.] *Where that matter adhering to comets arises from.*

And so, since it has already been shown more than enough in Book VI how matters stood not only with the heads of the comets of the years 1618, 1652 and 1661, duly observed with telescopes, but also with all the others, as we are thoroughly persuaded from these: namely, that the heads of comets consist of very diverse nuclei and corpuscles, partly very opaque and very dense, partly of rarer and thinner matter; but that they are by no means exactly spherical bodies, or purely diaphanous ones, which have parts homogeneous on every side, but heterogeneous [parts] of different size and shape; so that they are composed

of bodies both round and spheroidal, and angular; which, moreover, grow and shrink over time, join together and separate, and take up various positions relative to one another — as we have set out at greater length in its proper place. It follows from this that when the Sun illuminates the comet with its very strong and very brilliant rays — the comet whose body, as was explained in the previous Book, is entirely like a disc, which always turns one or the other of its flat faces toward the Sun (as we shall demonstrate at sufficient length in the next Book) — and since the solar rays, by reason of these various corpuscles, which lie at the most diverse inclinations, and of their various sur-

[Margin: Quâ ratione caudæ Cometarum procreentur.] *How the tails of comets are produced.*

[Margin: Cometa perpetuò Solem reſpicit.] *A comet always faces the Sun.*

faces, and also by reason of that subtler matter interspersed here and there, are partly reflected and partly refracted — and that in diverse ways. For if the more dilute matter is placed behind the bodies, the solar rays are first reflected and then refracted; but if the rarer matter comes first, the contrary happens. Indeed, if diverse nuclei precede and follow one another, and the thinner matter is variously intermixed with them, then the refraction and reflection of the rays also becomes diverse as a result — and that according to the angle of incidence and of reflection. In this way, therefore, the solar rays pass through the head of the comet to the region opposite the Sun, and there they are gathered as if into a bundle and drawn together; and from them the tail afterwards results, visible.

Now, as we were just saying, these reflected and refracted rays of the Sun must descend into some matter denser than the rest of the aether, so that they are stopped and are again refracted in diverse ways, according to the various degrees of density and rarity of that matter adhering to the comet, so that they can be seen: for in the purest aethereal air the rays can by no means be terminated, but all vanish entirely. So the question is: from where does this matter, somewhat denser than the aether, come to comets? You learned in the preceding Book how comets are born and generated, namely from the subtler exhalations and evaporations of the planets: they take at first a certain slender beginning, and then grow little by little in proportion to the inflowing matter, until, decreasing again, they are entirely dissipated in the course of time — as happens with the solar spots, as we showed more fully in the Book cited. Likewise I would have you know here that while this matter of the planets is coagulated and condensed in that way, and diverse bodies or very dense nuclei are generated from it, at the same time a great deal of more dilute matter, intermixed with the bodies, remains in that cometic body. This matter is not so tightly joined and compacted that it could come together into more solid corpuscles; rather, it utterly rejects all condensation, as being least suited to coagulation. Add that a still far greater quantity of the subtlest effluvia is no less left outside the head of the comet, which as it were surrounds and accompanies that cometic body — just as happens to the Earth, indeed to all the other planets, from the vaporous sphere that encircles them; as we also clearly showed in Book

VI. So around comets, since a great deal of more dilute matter always adheres to their heads on every side, and they are as it were hedged about by it, there is likewise a kind of cometic atmosphere. For it is surely credible that where denser matter occurs, thinner matter is also present in the same place. For at the beginning all the evaporations and effluxions of the planets, before they are condensed and united together, are extremely subtle and extremely thin; only some part of them, as being better suited to condensation, is coagulated, while the remaining matter stays constantly in a state, as it were, more dilute. This is what the solar spots openly show us: namely, that around the Sun itself subtler exhalations, very dilute shadows and little lights perpetually fly about and follow it round in a circle — expirations, which elsewhere we call secondary, of which the Sun, believe me, is never free. And although these sometimes pass away into nothing, and return to their body at a fixed time, yet others of the same nature are continually substi-

[Margin: Radii Solares non niſi in medio quodam denſiori ſiſtuntur.] *The solar rays are stopped only in some denser medium.*

[Margin: Generatio Cometarum.] *The generation of comets.*

[Margin: Non omnis materia Cometarum dilutior adeò conſtipatur,ut corpora, ex eâ, ſolidiora procreari poſſint.] *Not all the more dilute matter of comets is compacted so far that more solid bodies can be produced from it.*

[Margin: Circa Cometas dari atmoſphæram.] *That there is an atmosphere around comets.*

[Margin: Id quod maculæ Solares demonſtrant.] *This the solar spots demonstrate.*

tuted. In a similar way, when spots arise on the Sun's disc, a great quantity of such subtler matter usually follows them, which are called shadows and faculae; and not rarely they grow so much that they exceed the primary spot itself almost forty times in their bulk — such as, you should know, were observed by us on 1643 July 20, to our great wonder indeed.

[Margin: Admirandas Faculas & umbras in Sole Autor conſpexit.] *The Author saw wonderful faculae and shadows on the Sun.*

In this way, therefore, as soon as some comet is born, such subtler and thinner matter also suddenly arises around the comet. For since such thinner exhalations, cast out from the planets, wander everywhere through the whole aether in great numbers, it usually happens, while the cometic body is carried through the aether with a continuous and indeed very swift motion, that in the course of its journey (according as more or less matter is met with) more and more of such very subtle expirations come to the cometic body and adhere to it. And just as it happens in our sublunary air that a small cloud coming upon another easily joins and associates itself with it, so likewise that aethereal matter, from a natural propensity and an innate faculty of joining itself together, coheres the more readily. For like is most strongly inclined to union — which we likewise clearly observe in quicksilver, liquids and vapours. And so it comes about, while matter takes up in great abundance the matter it sometimes meets

on every side, that these subtler exhalations easily extend into a very vast mass around the head of the comet.

[Margin: Quo pacto materia illa circa Cometam tenuior, in adeò maximam excreſcat molem.] *How that thinner matter around the comet grows into so very great a mass.*

These exhalations, however, do not always beset the head of the comet entirely equally on every side, as if it were encircled by a perfectly round sphere; rather, now more, now less matter accrues on one or the other side of the cometic body, according as such matter flows in abundantly from this or that region of the aether. And so, with respect to us, this heap of the subtlest exhalations swells more now on the nearer side of the comet, now on the farther, now on one side or the other. But on which side of the cometic body do you think that matter adheres to it more readily? As far as we can guess by conjecture, it is not unfitting that this happens at the rear — that is, in the region opposite [to that] into which the comet is carried by its motion — or on that hinder side, by reason of the trajectory. For it seems that bodies so opaque, such as those of the comets and of the spots, and moreover endowed with so very swift a motion, can easily pass through and permeate the thinner matter that comes upon them; so that in this way, because of the immense velocity of the motion, that subtler matter can hardly adhere so much at the front (that is, on the side toward which they are heading) as on either side and at the rear. But although this does not seem so very absurd, the Sun nevertheless, in my judgement at least, in some measure prevents it from being able to come about in that way. For the Sun, illuminating and striking the comet with its very strong rays on the side turned toward it and on both flanks, rarefies, attenuates and dissipates that thinner matter and those subtler aethereal exhalations adhering to those sides more than it does those on the side of the comet turned away from the Sun; so much so that by its heat and the force of its rays it drives those expirations that face the Sun into the region opposite the Sun. For that reason the greater part of that rarer matter usually follows the comet on the side opposite the Sun; the greater part, I say, of the thinner exhalations, and their somewhat denser parts — not absolutely all the matter — occupy the said region.

[Margin: An ſubtiliores illæ evaporationes æthereæ,ab omni parte æqualiter corpori Cometico ſemper adhæreant ?] *Whether those subtler aethereal evaporations always adhere equally to the cometic body on every side?*

[Margin: Major pars expirationum tenuiorum Cometam concomitatur à parte ejus à Sole aversâ.] *The greater part of the thinner expirations accompanies the comet on its side turned away from the Sun.*

And I am going to prove this again, plainly, from the solar shadows, faculae and little lights. In them it is observed, when some notable stretch of them is present with a spot lying near the rising horizon, that this shadow is always more easterly, nearer the horizon and farther from the Sun than the spot itself; that is, it lies on the side turned away from the Sun with respect to the primary spot,

along the line drawn from the centre of the Sun through the spot. Conversely, when the spot is near the setting horizon, the shadows and faculae usually appear to precede it and to be nearer the horizon than the spot itself; that is, they are likewise opposite the Sun. But when the spot and its shadows linger near the centre of the Sun, as if in conjunction, the shadows surround the spot almost equally on every side, so that they seem neither to follow nor to precede. For everything that, in relation to our eye, lies not at the very perpendicular, or at a right angle, but at some inclination, is always seen to follow — and indeed on the side that is left with respect to us — while on the right side it is always seen to precede; and again, near the centre, it seems equally distant on every side. So this phenomenon arises only from the oblique and the direct view, as it would be easy to demonstrate from optics if it were advisable to dwell on these matters a little. But since anyone who has tasted optics only with the tip of his lips will easily understand that it is so, I gladly pass it over.

[Margin: Vnde id ipſum demonſtretur.] *From what this very thing is demonstrated.*

[Margin: Phænomenum vald[[è/é]] notabile circa faculas, umbras atq̃; lucuLasSolares.] *A very notable phenomenon concerning the solar faculae, shadows and little lights.*

Diagram. An engraved figure set into the text beside the narrow-measure lines: the disc of the Sun as a large circle, with straight lines radiating from a point near its centre. Between pairs of these lines lie sectors, each drawn with a dark spot surrounded by hatched faculae and dotted shadows; the horizontal pair at left and right encloses the ecliptic. Two further spots with shadows, one at the top of the disc and one in its lower part, carry no letter. The labels at the left and right are set vertically along the rim.

- Top of the circle: Septentrio. — North
- Upper left sector: D
- Upper right sector: F
- Outside the circle at the left, set vertically: Horiz. Orient. — Eastern horizon
- Left sector, above the spot: A; below it along the line: Ecliptica. — Ecliptic
- Centre, below the central spot: B
- Right sector, above the spot: C; to its left along the line: Ecliptica. — Ecliptic
- Outside the circle at the right, set vertically: Horiz. Occid. — Western horizon
- Lower left sector: E
- Lower right sector: G
- Below the circle: Austrum. — South
- Lower right, outside the circle: Autor ſculps. — The Author engraved [it].

For the sake of better understanding, however, I think a diagram should be added, so that even someone wholly unversed in optical matters may grasp how the shadows sometimes appear to follow the spot, as at A; sometimes to surround it entirely, as at B; and sometimes to precede it, as at C. Here I would have you note that when a spot lies outside the ecliptic in the northern part of the Sun, for instance at D and F, the shadow is always seen somewhat higher; in the southern part, by contrast, it is constantly seen lower. Experience itself attests that these things really do happen so in the spots and shadows. Indeed, if you refuse us credence, consider what Scheiner, that tireless investigator of these phenomena, recorded in *Rosa Ursina*, Book III, at Image XXXVI, p. 246, no. II: "The spot or shadow d, doubled," he says, "is seen in the eastern region to have followed the spot a, and in the western to have preceded it — which I have also noticed in other appearances of spots, investigating them with particular care." Likewise on the following page, 262, no. I. 20: "How the shadow and facula around the spot d suddenly appeared thrust out so far toward the western margin that from that margin no more

[Margin: Quâ ratione, & quando umbra maculam præcedat,rursusq́; ſequa ur.] [recte: ſequatur] *How, and when, the shadow precedes the spot, and again follows it.*

[Margin: Aliud phænomenum notatu dignisſimum circa Maculas umbrasq́;.] *Another phenomenon, most worthy of note, concerning the spots and shadows.*

[Margin: Inſignis obſervatioScheineri.] *A remarkable observation by Scheiner.*

distant was it than the spot itself, whereas otherwise it always followed the spot that went before it. Similar things happened around the spots a, and, in the earlier diagram, at the spot c: such things as you will notice here and there in other courses too."

Scheiner, then, as you have learned, rightly noticed this very thing — that it always happens so and not otherwise. But, as far as I know, he adduced in his work no clear reason for it: from what source this phenomenon takes its origin, that the shadow and the more dilute matter of the spots always lie hidden in the part perpetually opposite the Sun, and so always accompany the spot in that position. When we weigh this matter somewhat more deeply, however, we find no other reason than this: that the Sun, by the force of its rays, strongly drives away from itself that somewhat rarer matter facing it (although by nature it tends to follow and imitate the spot along the course of its journey), rarefied, attenuated and dissipated on every side — namely to the side opposite with respect to the spot. For this reason the shadow is necessarily subject in this way to all those appearances of which we have just spoken.

[Margin: Cur umbræ maior pars in parteSoli aversâ deliteſcat ?] *Why the greater part of the shadow lies hidden on the side turned away from the Sun.*

Since, therefore, all the appearances are saved by this supposed reason, everyone will freely admit with me that it is certainly so and not otherwise. If, then, the Sun exerts such great forces on the thinner matter of the spots (which is nevertheless far more turbid than the matter of comets, and indeed so thick

and opaque that it can be observed very well with the armed eye) that it is able to thrust out and drive the greatest part of it into the region turned away from itself, how much more readily, surely, will the Sun, with its most vivid and strongest rays, turn aside and repel into the parts turned away from it most of those far subtler expirations of the planets that lie around the head of the comet, in no way perceptible — even though by nature they are carried no less toward the rear, by reason of the line of the path?

[Margin: Evidens argumentum ex umbris, atq; maculis depromtum, pro caudis Cometarum.] *A clear argument for the tails of comets, drawn from the shadows and spots.*

But I would not have you think, kind Reader, that this matter usually adhering to comets is as dense and thick as our terrestrial clouds or the vaporous air surrounding the Earth. Rather, these are by far the subtlest aethereal evaporations, which can nowhere be detected by anyone once the body of the comet is removed; nor do they produce any refraction, either in the rays of the Sun or in those of the other stars, unless those rays, reflected and refracted by the denser matter and the nuclei that make up the head of the comet, have first fallen into that thinner matter adjacent to the comet. For even though the Sun sometimes illuminates those thinner evaporations when no comet is present, the solar rays are nevertheless by no means fixed there, since they pass straight through, as through our air; and consequently they are not seen. Hence it also comes about that a tail very rarely appears in comets on the side turned toward [the Sun], or on either flank, unless perhaps the rays are reflected in abundance from the head of the comet toward the Sun, so that they can in some way be seen, as we shall explain more fully in its proper place. But when the solar rays, reflected and refracted, pass through the cometic body right into the thinner matter attached to comets, they are at once drawn together as if into a bundle and gathered, and come clearly into view; and so the tail, or coma, of the comet arises. And the more the bodies that make up the head of the comet are opaque and dense, and the better suited to reflecting the rays of the Sun,

[Margin: Materia illa, quæ Cometas concomitatur, longè tenuior aëre noſtro vaporoſo.] *The matter that accompanies comets is far thinner than our vaporous air.*

[Margin: Et nullam omnino inducit refractionem.] *And it induces no refraction at all.*

[Margin: A parte Cometæ Soli obversâ, rarò cauda conſpicitur.] *On the side of the comet turned toward the Sun a tail is rarely seen.*

collecting, and compressing [them] into a single mass, and [as] the more dilute matter adhering to the head on the side opposite the Sun [is] ampler or narrower, denser or rarer, so accordingly the tails too appear now longer, now shorter, now brighter and thicker, now paler and rarer, as we shall see shortly. In short, no tail of any comet whatever exists, nor can the solar rays ever be seen, unless the rays first pass through the head of the comet into that adjacent thinner matter, so often mentioned, which adheres to the comet (and which is like a cometic atmosphere), and are halted and brought to an end there.

It is therefore quite clear from what has been said that we do not agree with Kepler that this matter is expelled from the head of the comet. In our opinion, rather, that matter is almost the same as the matter of which the body itself consists, except that it is much subtler, more fluid and rarer, and not so inclined to coagulate, condense and pass into nuclei; just as here in our air not all vapours and exhalations come together into the densest meteors, but very many of them are preserved for some time like the thinnest little clouds and clouds. Kepler, indeed, in Chap. VI, n. 13 of the *Astron. Opt.*, as we mentioned above on p. 471, n. 6, breaks out into these words: *"Finally, what is it that receives the ray of the Sun and, struck by it, shines back, displaying the shape of a tail? For if you say that it is matter belonging to the essence of the comet, you will have invented a most monstrous thing."* So he almost inclines to the view that it can hardly happen that so much matter and exhalation is supplied around a comet as would fill as great a space of the heaven as the tails of comets occupy, which not rarely run out to 20, 30, 40, 50 and more degrees. For unless that matter which follows the comet is dilated and extended so widely, the hair cannot reach so great a length either. And this is so very true that it can by no means be challenged.

We must therefore work to show that an equal heap of materials, and indeed a very long and very ample tract of thinner expirations, can sometimes be accumulated around a comet; and I do not doubt that I shall accomplish this successfully by means of the spots and shadows of the Sun. For it cannot be denied that around a solar spot of scarcely 20″ in magnitude a tract of shadows is sometimes found eleven minutes long, that is, thirty or even forty times longer than the spot itself (as was observed by us in the year 1643, on July 20); and this shadow, believe me, was 1200 times more capacious and ampler in respect of its area. If you bring this [?] down as far as the Moon, that is, to about 60 semidiameters of the Earth, it will run out, on our hypothesis, to 15 degrees, as is clear from the table inserted in Book VII, p. 403. Moreover, the observations testify that around the Sun, not only at a certain time but day by day, far more of this same subtler matter, or secondary shadow, is found, which as it were veils the whole Sun, and not only equals its disc in size but without doubt greatly exceeds it. Yet, granted that this matter and secondary shadow by no means exceeds the disc of the Sun, nevertheless, if it were brought down to a distance of 60 semidiameters of the Earth, that shadow would subtend and claim for itself a space of the aether of 45° or 50°, in longitude as much as in latitude; let alone if still a little below the Moon

[Margin: Pro qualitate capitis Cometici nunc cauda longior, nunc lucidior eſt.] *According to the quality of the comet's head, the tail is now longer, now brighter.*

[Margin: Autor ſententiæ Kepleri non ſubſcribit.] *The author does not subscribe to Kepler's opinion.*

[Margin: Keplerus diffidit posſe tantum materiæ circa Cometam ſuppeditari, quantum quidem ad caudas longisſimas exhibendas requiratur.] *Kepler doubts that as much matter can be supplied around a comet as would be required to display the longest tails.*

[Margin: Autor verò contrarium ſuſtinet : posſe tantum materiæ, quantum opus, etiam ad omnium longisſimas caudas, produci.] *The author, however, maintains the contrary: that as much matter as is needed, even for the longest tails of all, can be produced.*

[Margin: Vmbræ Solares quantæ magnitudinis appareant,ſi in orbe Lunari verſarentur.] *How great the solar shadows would appear if they were in the lunar orb.*

[Margin: Vmbra ſecundaria,nonnunquam in certo à terrâ intervallo, 70 & ampliùs grad. ſubtendit.] *The secondary shadow, at a certain distance from the Earth, sometimes subtends 70 degrees and more.*

that shadow were carried down; that is, to such an elongation as comets sometimes travel at (as happened to that [comet] of the year 1618 at a certain time), its length would exceed 60, indeed 70 degrees; and so the tails of comets too can reach so great a length. Indeed, at no other time are they seen so long and so stretched out as when they come very close to the Earth; but when they are carried back again to more remote regions, as far as the Sun or somewhat farther, then, as experience testifies, they certainly spread a more compressed mane.

Since, then, we hold it as certainly established that so great and immense a heap of materials, namely of primary shadows around the spots and of secondary shadows around the Sun itself, is sometimes found in a still far greater quantity, it is surely not absurd either that such thinner expirations also exist around comets. For while comets not rarely cross the orbs of almost all the planets, they draw in a great deal of matter everywhere and carry it away with them; so much so that in a very short space of time, since they enjoy a very swift motion, they can pile up a vast heap of those very subtle exhalations, suitable for refracting a tail.

In this matter, I say, now rather rare, the light of the Sun, driven through the head of the comet and reflected by its nuclei, but refracted by the somewhat more dilute matter, is halted in the region opposite the Sun, and a tail is formed. According to the constitution of the head, however, and to the matter adhering to the comet, the tails take on a varied appearance and display dissimilar shapes, according, that is, as the solar rays, sent through the head of the comet, intersect and cross one another now in this way, now in another, in the adjacent more dilute matter.

This intersection and crossing of the rays in the rarer adhering matter takes place chiefly in three ways, from which the most diverse forms of tails afterwards result. First: the head of the comet is sometimes so composed that the rays passing through it, reflected and refracted, come together as if into one point, and intersect one another, only near the end, as is seen in figure A; and then the tails end in a point. Of this kind was the comet of the year 1652, and very many others. Second: when the cometic body is so constituted, and the solar rays passing through the head of the comet are so disposed, that from one side or the other of the head they at once run together crosswise and begin to cross,

the tails are in this way narrowed around the head and have, as it were, a neck, while in the middle and at the end they gradually widen and spread out, as happened in the comet of the year 1618. This mostly happens if in the middle of the head one or another nucleus of remarkable size is lodged, with smaller ones scattered variously on either side, from which the principal reflection and refraction of the rays must arise; for then of necessity they fly together behind the head as if into one centre, intersecting one another, as anyone who examines and weighs this very point will readily judge. Third: when, however, the concentration of the rays, owing to that constitution of the head and of the matter, takes place not at all in one point, nor in some points very close to one another, but in various points somewhat farther apart, then, I say, the tails, as usually happens in comets and as was also observed in the year 1647, begin to widen and separate gradually from the head right to the end. That, nevertheless, even in comets of that kind, the tails sometimes at the very end

[Margin: Poſſe ſufficientem effluviorum tenuiorum copiam, circa Cometas dari, etiam pro longiſſimis quibusvis caudis exhibendis.] *That a sufficient supply of thinner effluvia can exist around comets, even for displaying any of the longest tails.*

[Margin: Ratio apparitionis Caudæ Cometicæ.] *The cause of the appearance of the cometic tail.*

[Margin: Vnde tam variæ caudarum ſpecies exoriantur.] *From what source such varied appearances of tails arise.*

[Margin: Caudæ,quando in mucronem terminentur, & rursùs quando circa extremitatem dilatentur.] *When tails end in a point, and again when they widen near the end.*

Diagram. A full-page engraved plate in two parts, captioned *Fig.O.* at the lower left and signed *Autor ſculpſit.* ("The author engraved [it]") at the lower right. The upper part has four figures, one above another, lettered A, B, C and D. Each shows, at the left, a rayed disc lettered S; two straight lines run from it to a mottled, bristling disc lettered c; and from that disc a tail of hatched lines runs to the right. In A the tail runs out into a long narrowing train ending at a single letter g. In B the tail is pinched into a narrow neck beside the head, marked g above and g below, and then spreads widely. In C the tail's lines cross one another, with g set above and below it at three places along its length. In D the tail is narrow and nearly parallel-sided, marked g above and below near its start. The lower part is a large circle. A vertical line runs down from I at the top, labelled *Septentrio.* ("North"). At the left, G stands on the circle beside a small rayed half-disc, with M above it on the circle and *Ortus.* ("Rising") outside it; at the right, A stands below a rayed half-disc on the circle, with *Occaſus.* ("Setting") outside it. A line from G, labelled *Horizon.*, and a line running to A, labelled *Horizon*, belong to a curve passing below the centre between G and A. Below that, an arc runs from G through rayed half-discs lettered F, E, D, C and B to A, labelled *Revolutio … Solis.* ("revolution of the Sun") on either side of D. Ten star-shaped bodies with several radiating tails each, numbered 1 to 7 in a row across the upper half and 8, 9 and the tenth below them, stand

inside the circle; ruled lines run from every half-disc to the bodies' centres, and a small letter b stands at or below most of the centres. Round the tail tips of bodies 6 and 7 the letter c is set seven times each, and L stands beside the last c of body 7. K stands at the foot of the circle.

- Upper part, figure A: S (above the rayed disc), c (above the mottled head), A (above the tail), g (at the tail's tip).
- Figure B: S, c, B; g (above the tail's neck), g (below it).
- Figure C: S, c, C; g (above) and g (below) next to the head; g (above) and g (below) further along; g (above) further still.
- Figure D: S, c, D; g (above) and g (below) the tail near its start.
- Circle, top: I; *Septentrio.* along the vertical line ("North").
- Numbered bodies: 1, 2, 3, 4, 5, 6, 7, 8, 9; the tenth body's numeral is a two-figure number ending in 0, its first figure unsettled [?].
- Letters at the bodies' centres: b at bodies 1, 2, 3, 4, 5, 6, 7, 8 and 10; at body 9 an unread letter [?].
- Round body 6: c seven times; round body 7: c seven times, with L at the right.
- Left: M (on the circle), G (at the rayed half-disc), *Ortus.* ("Rising"), *Horizon.* ("Horizon").
- Right: A (at the rayed half-disc), *Occaſus.* ("Setting"), *Horizon* ("Horizon").
- Lower arc: F, E, D, C, B at the rayed half-discs; *Revolutio* and *Solis.* on either side of D ("revolution of the Sun").
- Foot of the circle: K.
- Plate caption and signature: *Fig.O.* ("Fig. O."); *Autor ſculpſit.* ("The author engraved [it]").

appear a little sharper comes about, I think, from no other cause than that some livelier rays shoot out and run on somewhat more strongly and farther than the others.

But so that all this may be perceived more clearly, we have decided to sketch this threefold mode of crossing of the solar rays in some figures. Let S, then, be the Sun, sending its rays through the head of the comet C so that they are concentrated at g, first in that more dilute matter adhering to the head. While this happens, the tail necessarily shines out pyramidal, as in delineation A, and appears tapered to a point. But when the rays cross immediately below the head (as you see in B), the tail is at first indeed compressed more tightly, but afterwards spreads and widens more and more right to the end. Again, in C, since the crossing of the rays takes place there at various points fairly far removed from one another, the tail diverges slightly. According to the constitution of the head, therefore, and to the differing intersection of the rays, the tails take on now this appearance, now that; above all according as that more dilute matter, in which the Sun's rays are halted and fixed, is now in this part, now in that, denser or thinner — as we shall explain more fully on this subject when we treat of the curvature. Concerning this crossing of the

rays, we want you to be advised that the rays sometimes intersect one another crosswise in only two places, as can be seen in diagram D; and then the comet is slanted with crescent-shaped horns, or shines with a forked tail and two very long rays: as was observed in Scotland in the year 1169, on the testimony of Cardanus, Book II on the *Quadripartitum*, text 54; or in the year 1165, as Hector Boëtius records in his *History of Scotland*, Book 13.

[Margin: Quâ ratione triplex illa radiorum decuſſatio in materiâ,circa-Cometam,rariori accidat.] *How that threefold crossing of the rays occurs in the rarer matter around the comet.*

[Margin: Quo pacto Cometa bifurcatus repræſentari poſſit.] *How a forked comet can be represented.*

However, in whatever way the solar rays cross and intersect one another in the end, the tail always, as we also noted in the second question of this Book, points almost to the part turned away from the Sun. For this reason the tails of comets are seen to incline now to the east, now to the west, now toward the south, now toward the north. Indeed, in one and the same comet, when it is more stable and longer-lasting and, through its proper motion, occupies a different place with respect to the Sun, it is frequently found that it casts its tail now toward the east, now toward the west; and in such diverse ways that we are in no way able to express all those variations, because of the varying position of the comet and the Sun. Meanwhile, however, wherever the tail may point, it is always cast toward the region opposite the Sun, as has been urged quite often. This, however, was entirely unknown to the ancients, and it also greatly confused a great many of the more recent philosophers and historians, so that they inclined chiefly to the view that the hair of comets does not at all times point toward the part opposite the Sun, but in every direction; as is clearly evident from Bodin, and from Keckermann, *Physic.* Book VI, Chapter V: *"It has been handed down,"* he says, *"that the tail of comets is turned away from the Sun; and this is indeed often noticed in eastern and stationary comets, but in the rest it is found to be false."*

[Margin: Caudæ in quamcunq; ætheris plagam vergunt; ſemper tamen in partes propemodum Soli oppoſitas.] *Tails incline toward any region of the aether whatever, yet always toward parts nearly opposite the Sun.*

[Margin: Abſurda nonnullorum opinio, caudas promiſcuè quaquaversùm tendere.] *The absurd opinion of some, that tails point indiscriminately in every direction.*

But how the tails, in their different positions, are always directed opposite the Sun — since this could not be done up to now — will now at last be shown clearly from the lower diagram. In it let the circle AIGK be the equinoctial colure; AHG the horizon; ABFG the revolution of the Sun below the hori-

[Margin: Quâ ratione ſemper in Solis oppoſitum Caudæ projiciantur Schemate demonſtrantur.] *How tails are always cast opposite the Sun is shown by a diagram.*

zon on the north side; IHK the northern meridian; the line LM the orbit of the comet b, in different positions; ABCD etc. the Sun; the lines running from the Sun through the centres of the comets show the course of the tails. Various tails have indeed been drawn on each comet; yet not so many are seen at once and together, but at different times: according as the Sun or the comet stays in this place or that, the comet displays its hair now in this way, now otherwise. We have therefore deliberately presented this phenomenon drawn in this manner, so that you may recognize all the better the difference in how the tail is produced in this position or that. There you will notice how the tail varies, both if you suppose the Sun fixed, for example, at A at its setting, and change the comet's place, and if you make the comet immobile and the Sun mobile; although cases of this kind rarely occur, since the Sun and the comet move continually with their own motion. It can therefore happen, while the Sun is at its setting at A, that the tail now inclines toward the north, as is evident from the line A 7; now runs out its course toward Hellespontius, along the line A 5; now toward Eurus, along A 1. Again, if the comet is placed nearer the horizon, for instance at numbers 8, 9, 10 and 11, the tail, while the Sun is at its setting, is stretched out toward the rising; conversely, when the Sun is at its rising, the tail extends toward Zephyrus. And so the hair is cast toward every region of the sky, according to the differing position of the Sun and the comet, as is abundantly clear from the drawing.

[Margin: Pro Solis &Cometæ ſitu,cauda nunc hanc, nunc illam plagam versùs protenditur.] *According to the position of the Sun and the comet, the tail stretches out now toward this region, now toward that.*

Finally, regarding this direction, let it be well noted, as we have already duly pointed out, that the tail is indeed always driven opposite the Sun, but not so entirely precisely that it deviates in no way to this side or that. For experience testifies that tails mostly deflect a little from the point opposite the Sun, that is, from the straight line drawn from the centre of the Sun through the comet; and this befalls not only those comets that are endowed with curved tails, but also those with straighter ones. I am fully convinced that something similar happened in the comet of the year 1577, although Tycho holds that its tail was directed not entirely toward the region opposite the Sun, but toward the quarter opposite Venus; but the matter belied his opinion, as he himself afterwards rightly acknowledged. For he could in no way persuade himself that tails could draw so much light from Venus. It must therefore be ascribed to the deviation and inclination of the tail that the train of that comet was not stretched out entirely opposite the Sun; of which more will be said shortly.

[Margin: Exporriguntur quidem Caudæ ſemper in oppoſitum Solis; ſed cum certâ quâdam deviatione.] *Tails are indeed always stretched out opposite the Sun, but with a certain deviation.*

Tycho, although he was entirely ignorant of the cause of this, was nevertheless among the first to notice this deviation of the hair. For others too observed it in certain comets. Thus Johannes Hommelius [Johannes Hommel] found

in the comet of the year 1556 that the tail did not appear turned exactly away from the Sun as long as the comet was a quadrant away from the Sun, but that afterwards it pointed directly opposite the Sun. So too the Landgrave of Hesse found in the year 1558 that the hair deflected by 10 degrees from the point opposite the Sun. Likewise Mästlin recalls that he noted in the year 1580 that the hair was turned away from the Sun at first with some bending, but afterwards entirely in a straight line. For he says: *"The tail — as has been common to all comets observed so far — opposite the Sun, al-*

[Margin: Etiamſi deviatio caudæ Cometicæ jamTychoni ſuboluerit; tamen cauſam ignoravit.] *Although the deviation of the cometic tail was already sensed by Tycho, he did not know its cause.*

[Margin: Caudas à rectâ line[[â/á]] deflexiſe, exemplis probatur.] *That tails deflect from the straight line is proved by examples.*

though not exactly diametrically opposite, it had." (page 13, Chapter II, *On the Comet of 1580*). Likewise, in the year 1582 a comet displayed an inclination of the tail almost similar to the one the comet of the year 1577 displayed, as Tycho clearly indicates in Book II, Chapter 9, page 204.

Moreover, Kepler asserts in the *Physiology of Comets*, page 102, that in the comet that shone in the year 1607, and also in the two that followed in the year 1618, the tails were found to have deviated a little from the straight path. *"For it is usual for comets,"* he says on page 54, *"that their tails deflect somewhat from the point opposite the Sun."* Gassendi noted the same in the comet of the year 1618: that its direction, namely, was not precisely toward the quarter turned away from the Sun, as can be read in *Philos. Epic.*, page 1151. From the observations of Cysat, Chapter IV, proposition 2, it appears still more clearly that in the year 1618 the deviation of the leading comet extended to as much as five degrees; although, according to our calculation from the same observations, the inclination of that tail was still much greater, as we shall shortly explain more fully. Finally, it is also evident from the calculation of our own comet that for almost the whole time of its duration the tail deflected from the straight line.

[Margin: Deviatio caudæ, quanta extiterit Cometæ anni 1618.] *The deviation of the tail: how great it was in the comet of the year 1618.*

Cysat, indeed, holds the view that this deviation of the tail arises from no other source than that the tail cannot be observed very precisely; but he is certainly mistaken. For this phenomenon does not originate in some error committed or in a deception of sight; it is really present in comets, as is to be confirmed best of all, in due course, by the comet of the year 1652. Since this is so, it is now rightly asked what the genuine reason for this phenomenon is. If we weigh the matter somewhat more carefully, we find no other reason than that this deviation arises from a most diverse and varied refraction and reflection of the rays. For, as you have learned, the heads of comets are composed of very diverse and numerous irregular bodies, which hold various positions relative to one another and gradually change their places, so that now on this side, now on that, more or fewer nuclei are present and packed together. Hence it can

easily happen that the Sun's rays, reflected and refracted as they pass through the comet's head, do not always cross on that very straight line drawn from the Sun through the comet; rather, the refraction and reflection of the rays takes place in entirely different ways, now in this part of the head, now in that. For the matter is not always uniform, nor are the surfaces of the corpuscles and nuclei, and the inclinations of their sides, always the same; and from this it certainly follows that the tail must sometimes necessarily deviate a little from the straight path. According to the constitution of the head, therefore, and of its matter, now of one kind, now of another, a greater or smaller declination and deviation of the tail comes about; and sometimes the refraction of the rays is entirely uniform, so that the tail does not deviate at all, but points straight opposite the Sun.

[Margin: Quænam genuina hujus phænomeni ſit ratio.] *What the genuine reason for this phenomenon is.*

[Margin: Pro diversâ conſtitutione corporis Cometici, cauda diverſimode à recto tramite exorbitat.] *According to the differing constitution of the comet's body, the tail strays in different ways from the straight path.*

Further, it must be investigated, first, whether the declination or inclination of the tails always deviates equally from that arc of a great circle drawn through the head of the comets; second, how great it can be; and third, whether these deviations always keep to the same region of the sky. Just as these questions have hardly occurred to anyone up to now, so they certainly deserve to be duly investigated. As regards the first: since the inclination of the tail springs from refraction and reflection of the solar rays of one kind and then of another, as we were saying just now, it is eas-

[Margin: An declinatio Caudæ ſemper æqualis & quanta exiſtat?] *Whether the declination of the tail is always equal, and how great it is.*

ily evident that it cannot always remain the same, alike and equal to itself, but is now somewhat greater, now a little smaller, as is clearly found in some comets that were accurately observed: namely in the comets of the years 1577, 1590, 1607, 1618 and 1652. The deviation of the first from the straight path extended from 10° all the way to 22 degrees; the deviation of the second comet decreased from 6 to 2 degrees; that of the third comet, from 21° all the way to 10°; that of the fourth, on the contrary, widened all the way to 22°; and the declination of the tail of the last grew to 19 degrees, as is clear from the table that follows. If we had sufficiently accurate observations of more comets, it would be easy also to investigate how matters stood with all of them in this respect, and at the same time to determine precisely how great the deviation, when it appears greatest of all, really is in comets.

[Margin: Diverſitas deviationis exemplis quibusdam probatur.] *The diversity of the deviation is proved by some examples.*

As far as can be gathered from these five comets, however, the deviation did not exceed 22 degrees in magnitude — leaving aside the fact that the declination of the comet of the year 1577, as the calculation shows, grew to 38° 42′. For

I think that no trust at all is to be placed in this observation: Tycho himself admits that the comet was already very faint at that time, so that it was caught by the eye only with great difficulty. This observation is therefore rightly disregarded. But whether in other comets the deviation may not sometimes be somewhat greater is a matter for deeper inquiry, and one still hard to determine so precisely, since we entirely lack the accurate observations on which alone this matter rests. If, however, those who come after us watch this phenomenon more diligently than has so far been done by our predecessors, something more certain about it will be discovered in time. As far as we can reach by conjecture on this occasion, however, this deviation and extension of the tail seems hardly able to exceed 20 or 30 degrees; indeed, I would venture to state that more often it hardly runs out to 15, or at most 20 degrees. But whether I guess rightly, time will tell. Around the conjunction of the Sun and the comet, when they have a very short beard, it does indeed appear as if the tails deflect from the straight path by as much as 90 degrees; but this happens not in truth, only in appearance — and of this we shall speak toward the end of this Book.

[Margin: Deviatio caudæ, quanta ſit omnium maxima.] *The deviation of the tail: how great it is at its greatest.*

As regards the third question — whether the tails always decline toward the same part of the sky — it is almost more intricate than the others, since more solid observations are lacking here as well. Let us nevertheless work at it vigorously, so that the difficulty may be met and the matter investigated more thoroughly; and this, with the consent of divine grace, I hope will also turn out happily. But before we come to that, it will be worth the effort to bring into a definite small table the inclinations and deviations of the tails, duly computed, of all those comets that were observed properly and correctly beyond the others. Of all the comets ever noted, however, no more than five or six have been found that are adequate for this business, because of the deplorable and wholly inexcusable negligence of the old observers: namely the comets observed in the years 1577, 1590, 1607, 1618, 1647 and 1652.

[Margin: An caudæ ſemper ad eandem Cœli plagam devient?] *Whether tails always deviate toward the same region of the sky.*

The first comet — the more exactly Tycho searched it out with his instruments, the more rigorous the calculation to which he likewise subjected it: namely, whether it had thrust out its tail toward the region entirely opposite the Sun. When the examination was finished, however, he found that its tail did not point entirely in a straight line away from the Sun, but deflected partly to the side;

[Margin: Tycho ſibi perſuaſit,deflexionem caudæ, Veneri adſcribendam eſſe.] *Tycho persuaded himself that the deflection of the tail was to be ascribed to Venus.*

and from this he came to the view that this deviation was to be imputed to Venus. For that reason, in the whole calculation he did nothing else than show, at that place, that Venus, the head of the comet and its tail had advanced under

the arc of a great circle. He by no means examined accurately, however, to what extent the tail deviated from that circle drawn from the Sun through the head of the comet — that is, by seeking the angle B C D brought forward in the calculation above, page 466.

Since, therefore, this angle was by no means computed by Tycho, I myself willingly undertook to investigate, as diligently as possible and from Tycho's observations and data, the extension and deviation of the tail of that comet from the straight path of the Sun: namely the angle at the comet, or the angle contained by the tail and by the circle drawn from the Sun through the head of the comet. To spare paper and time we have left out the calculation itself here, and have set down only the bare table, in which you will have the given and the sought quantities in order. Under the first two columns you will find the day and hour of the observation; in the third, the longitude of the Sun; in the fourth and fifth, the longitude and latitude of the comet. The sixth gives the place toward which the tail was extended; the seventh and eighth, the longitude and latitude of that fixed star or place; the ninth, the distance of the head from the Sun; the tenth, the angle of the circle of latitude and of the distance, B C F; the eleventh, the angle of the circle of latitude and of the tail, H C D; the twelfth, the sought angle of deviation of the tail, B C D; and the last shows the deviation — whether it bent toward the south or rather toward the north. Everything has been worked out by calculation according to that method, as was done above on the occasion of our comet, page 464.

[Margin: Caudæ deviationem Cometæ 1577 Autor exploravit.] *The author examined the deviation of the tail of the comet of 1577.*

[Margin: Diſpoſitio tabulæ, quorund m Cometarum devia iones,exhibentis.] *Arrangement of the table showing the deviations of certain comets.*

No less, from Tycho's observations given in the letter to the Landgrave, page 177, we have carefully sought the direction of the tail of the comet of the year 1590, and have entered it in the attached table. It is, certainly, notable enough, even though Tycho, in the same place cited, reports: *from those extensions of the tail that we have indicated, it is clearly gathered that it was everywhere turned exactly away from the Sun.* And from this it is presumed that it had deviated to no side at all. But however that may be, he seems not to have inquired into this very point himself by an accurate calculation, but only to have derived it roughly from the globe; otherwise, had he investigated it duly, he would have detected deviations entirely similar to ours.

[Margin: Vt ut Tycho longe aliter ſenſerit, cauda tamen Cometæ 1590 notabiliter à rect[[a/â]] diſcesſit lineâ.] *However differently Tycho may have thought, the tail of the comet of 1590 nevertheless departed notably from the straight line.*

I have computed the direction of the comet of the year 1607 from Kepler's observations, which he set out in *De Cometis*, pages 33 and 34 — and indeed for as many days as the comet was observed by him. As for the comet of the year 1618, Joh. Bapt. Cysat did indeed take pains to work out the extension of its tail; but by a calculation undertaken in that way he could by no means

trace out the angle B C D. He determined only the difference of the angles, namely of the angle at the Sun contained by the ecliptic and by the circle of distance of the fixed star toward which the tail was inclining. Since that angle by no means shows the genuine deviation of the comet, it therefore fell to us likewise to investigate all the extensions of the tail by our own method. We found them, however, far different and larger, and not at all times northern, as the said Cysat asserts and computed: as our table shows. Lastly, we have also added the declinations of the tails both of the comet of the year 1647 and of that of 1652, as they were derived above by calculation; that of the comet of the year 1661 we reserve for its own place.

[Margin: Ex quibus obſervationibus Cometarum declinationes Autor ſupputaverit.] *From which observations the author computed the declinations of the comets.*

Month, day Hours	Longitude of the Sun A	Head of the comet: longitude F	Head of the comet: latitude F C	Place toward which the tail was extended: name	Its longitude E	Its latitude E D	Distance of the head from the Sun A C	Angle of the circle of latitude and of distance B C F	Angle of the circle of latitude and of the tail H C D	Angle of deviation of the tail B C D	Direction[?] of the deviation[?] from the circle of distance[?]
			North	Year 1577 &	1578.	North					
November 13	1° 20′ ♐	7° 15′ ♍	8° 59′	3.Gr.ſup.Aſſt.in cor. ♍	28° 21′ ♌	8° 41′	36° 53′	77° 47′	91° 58′	14° 11′	A.
14	2° 21′ ♐	20° 42′ ♍	8° 42′	2.Gr.ſup.ſu per. corn. ♍	28° 34′ ♌	9° 30′	39° 36′	76° 47′	92° 18′	15° 31′	
15	3° 22′ ♐	3° 47′ ♎	8° 16′	4.Gr.ſup.ſu per. corn. ♍	28° 34′ ♌	9° 30′	41° 56′	76° 0′	91° 29′	15° 29′	
20	8° 27′ ♐	26° 59′ ♎	8° 15′	* Extrema alæ Pegaſi.	3° 28′ ♈	12° 35′	51° 2′	74° 32′	84° 34′	10° 2′	A.
21	9° 24′ ♐	29° 14′ ♎	8° 9′	* Extrema alæ Pegaſi.	3° 28′ ♈	12° 35′	52° 24′	74° 29′	85° 40′	11° 11′	
23	11° 30′ ♐	31′ ♒	20° 45′	* ſuper. frontis Equul.	19° 44′ ♓	6° 54′	52′	74° 32′	85° 45′	11° 13′	
25	13° 31′ ♐	24′ ♒	22° 6′	* in Ore Pegaſi.	26° 12′ ♓	7° 56′	54′	74° 39′	86° 23′	11° 44′	A.
29	17° 37′ ♐	45′ ♒	24° 0′	⅔ Gr.Inf.ſeq.Or.Equul.	18° 44′ ♓	10°	59′ 24′	74° 44′	86° 52′	12° 8′	

Month, day	Hours	Longitude of the Sun A	Head of the comet: longitude F	Head of the comet: latitude F C	Place toward which the tail was extended: name	Its longitude E	Its latitude E D	Distance of the head from the Sun A C	Angle of the circle of latitude and of distance B C F	Angle of the circle of latitude and of the tail H C D	Angle of deviation of the tail B C D	Direction[?] of the deviation[?] from the circle of distance[?]
30		18° 38′ ♑	3° ♒	24° 29′	1. Gr. ſupra Os Pegaſi.	26° 12′ ♒	7° 59′	47′	74° 36′	95° 25′	20° 59′	
December 1		19° 39′	18° ♑	22° ♒	4° 47′ Marchab Pegaſi.	17° 39′ ♓	9° 28′	60° 13′	74° 37′	94° 10′	19° 33′	A.
10		28° 50′	27° ♑	47′ ♒	26° 50′ 3½ Gr.ſupra Marchab.	17° 39′ ♓	5° 0′	60° 53′	73° 38′	96° 8′	22° 30′	
12		0° 53′ ♒	27° ♑	21′ ♒	27° 8′ 5⅚ Gr.ſupra Marchab.	17° 39′ ♓	5° 15′	60° 33′	73° 11′	93° 41′	20° 30′	
December 30		19° 15′ ♑	3 14′	♑ 28° 42′	⅓ Inf.præc.pect. Pegaſ.	17° 20′ ♓	5° 30′	55° 40′	68° 2′	89° 40′	21° 38′	A.
January 12		1° 40′ ♒	5° 37′	♑ 29° 10′	* præc.duar.Pect.Pegaſ.	17° 20′ ♓	5° 50′	51° 3′	63° 11′	101° 53′	38° 42′	
				North	Year 1590.		North					
February 23	10h evening	15° 10′ ♓	8° 27′	♈ 8° 14′	* Pedis Androm. Lucid.	8° 31′ ♉	27° 46′	37° 26′	64° 31′	59° 1′	5° 30′	B.
24	10h evening	16° 10′ ♓	6° 21′	♈ 9° 33′	* Lucid. lateris Perſei.	26° 9′ ♉	30° 5′	43° 57′	68° 23′	62° 48′	5° 35′	B.
25	10h evening	17° 10′ ♓	4 17′	♉ 20° 24′	* in flex. lateris Perſei.	29° 15′ ♉	26° 14′	49° 29′	71° 28′	68° 54′	2° 34′	B.
26	10h evening	18° 10′ ♓	2 11′	♉ 20° 55′	* Algol ſeu caput Med.	20° 29′ ♉	28° 22′	54° 1′	73° 52′	80° 4′	6° 12′	A.
March 1	10h evening	21° 10′ ♓	0 57′	♉ 21° 15′	* in fæmore ſin. Perſei.	20° 3′ ♉	2° 6′	62° 56′	78° 33′	80° 19′	1° 46′	A.
				North	Year 1607.		North					

Month, day	Hours	Longitude of the Sun A	Head of the comet: longitude F	Head of the comet: latitude F C	Place toward which the tail was extended: name	Its longitude E	Its latitude E D	Distance of the head from the Sun A C	Angle of the circle of latitude and of distance B C F	Angle of the circle of latitude and of the tail H C D	Angle of deviation of the tail B C D	Direction[?] of the deviation[?] from the circle of distance[?]
October 1		8° 21′ ♎	8° 15′ ♑	37° 0′	Prope cingul. Bootis.	22° 36′ ♎	10′	38° 7′	16° 10′	37° 30′	21° 20′	A.
October 2		9° 20′	26° 0′ ♑	35° 0′	* Proximè ſeq. luc. Cor.	9° 20′ ♏	14° 33′	38° 18′	27° 34′	42° 53′	15° 19′	A.
October 7		14° 7′	18° 40′ ♏	3° 30′	* Sup. in hum.dex.	19° 51′ ♐	8° 1′	40° 49′	59° 46′	74° 7′	14° 21′	A.
October 22		29° 14′	1° 54′ ♐	9° 45′	* In dex.man. Oph. Au.	20° 10′ ♐	40′	32° 40′	75° 13′	85° 18′	10° 5′	A.
				North	Year 1618 &	1619.	North					
December 1	6h morning	8° 58′ ♐	9° 22′ ♏	10° 50′	* Seq. 3 in lin. rect. Alæ	22° 26′ ♎	8′	31° 41′	70° 8′	83° 40′	13° 32′	A.
7	4h morning	15° 10′ ♐	9° 23′ ♑	37° 0′	* Arcturi. (Bor. ♍	18° 55′ ♎	3′	51° 50′	65° 44′	66° 50′	1° 6′	A.
8	4h morning	16° 11′ ♐	8° 21′ ♑	29° 47′	* in gen.pr.pe.	22° 48′ ♑	14′	54° 22′	65° 47′	65° 54′	0° 7′	A.
9	6h morning	17° 17′ ♐	6° 18′ ♑	32° 29′	* in formis inter caudam Vrſ. & ♌	17° 58′ ♍	6′	57° 48′	66° 21′	65° 0′	1° 21′	B.
20	4h morning	28° 26′ ♐	21′ ♑	54° 11′	* ſequ. ſup. in □ Vrſæ.	25° 40′ ♑	37′	88° 18′	87° 37′	82° 10′	5° 27′	B.
22	8h evening	1° 0′ ♑	25° 0′ ♍	36° 0′	* Antepen. Caud. Vrſæ.	3° 25′ ♍	18′	93° 21′	94° 59′	88° 52′	6° 7′	B.

Month, day	Hours	Longitude of the Sun A	Head of the comet: longitude F	Head of the comet: latitude F C	Place toward which the tail was extended: name	Its longitude E	Its latitude E D	Distance of the head from the Sun A C	Angle of the circle of latitude and of distance B C F	Angle of the circle of latitude and of the tail H C D	Angle of deviation of the tail B C D	Direction[?] of the deviation[?] from the circle of distance[?]
24		2° 50′ ♑	3° 11♐	38° 44′	* Præced. ſup. □ Vrſæ.	9° 49′ ♎	49° 40′	96° 5′	79° 53′	87° 15′	7° 22′	B.
28	6h morning	6° 32′ ♑	31′ 11♐	30° 57′	* Infima in parvo △ colli Vrſ. Maj.	24° 5′ ♑	42° 36′	103° 11′	65° 3′	75° 45′	10° 42′	B.
January 7	8h evening	17° 21′ ♑	38′ 8♑	22° 28′	* ſub oculo ſin. Vrſæ M.	17° 25′ ♑	49° 55′	114° 55′	26° 58′	48° 26′	21° 28′	B.
				North	Year 1647.		North					
September 29	evening	6° 30′ ♎	0′ ♌	26° 0′	Prope hum. ſiniſt. Arct.	10° 0′ ♑	0° 0′	3° 0′	3° 25′	3° 9′	0° 16′	B.
				South	Year 1652 &	1653.	South					
December 20	10h evening	29° 49′ ♐	48′ 12♑	29° 21′	* Sup.ped.Orion.in Erid.	10° 26′ ♊	54′	143° 54′	39° 31′	58° 8′	18° 37′	A.
23	8h evening	2° 44′ ♑	28° 56′	♉ 0′	* In Oculo boreo ♉	3° 37′ ♊	1° 37′	146° 5′	85° 32′	85° 26′	0° 6′	B.
				North			North					
26	10h evening	5° 54′ ♑	24° 34′	♉ 20′	⅓ Gr.ſupr.Calc.ſin.Perſ.	26° 17′	18° 28′	136° 56′	75° 18′	62° 40′	12° 38′	A.
27	7h evening	6° 48′ ♑	3° 33′	♉ 6° 30′	Int. cr. ſin. & duas in pe.	28° 30′	14° 0′	134° 18′	73° 12′	63° 2′	10° 10′	A.
30	10½h evening	9° 50′ ♑	28° 23°	33′	* In ſin.gen.Perſ. (Perſ.	0° 52′ ♊	19° 4′	127° 34′	70° 34′	65° 35′	4° 59′	A.
January 3	7h evening	13° 58′ ♑	28° 11′	♉ 9° 3′	* In flex. lat. Perſei.	29° 59′	26° 14′	121° 6′	70° 26′	80° 30′	10° 4′	B.

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From this table, then, and from the deviations of these six comets, it is clearly proved, first, that the tails are not bound to an exact opposition, but deflect in various ways from the straight course, now toward the south, now toward the north. Thus this inclination sometimes increases and sometimes decreases, and not rarely it even remains for some time in a steady state, as if it were stationary. In some comets a certain reciprocation is detected; yet it is by no means regular, nor is it bound to any regular motion, because the motion of the bodies and nuclei that make up the head of the comet is extremely anomalous and varied.

[Margin: Exemplis deducitur deviationem diverſimodam, & inæqualem; motui tamen reciprocationis nonnunquam eſſe obnoxiam.] *From the examples it is deduced that the deviation is varied and unequal, yet sometimes subject to a motion of reciprocation.*

In the comet of the year 1577 it is plain at the very first glance that its inclination increased from 13 November up to the 15th; that from the 15th to 20 November it steadily decreased; and that again, up to 30 December and January, it was continually diminished — so much so that over the whole time of its duration it was neither less than 10° nor greater than 22°, the observation of 12 January being of course rejected as suspect. Above all, it should be well noted that while the comet was northern the deviation was always southern, toward the ecliptic. Tycho affirms this in Book II, Chapter VII, page 162: *By no means do I find* (he says) *that its extension proceeded exactly in a straight line with respect to the Sun, but that it inclined perceptibly from the arc of the great circle drawn from the Sun through the head of the comet toward the more southern part of the sky.*

570 The page is a single ruled table in thirteen columns, the one announced on the preceding page; its columns follow the order there described. The page prints the month name divided over two or three rows and the day beside it; here the month is given once at the head of its run of days. The group headers Capitis Cometæ. (of the head of the comet) and Loci, ad quem Cauda porrecta fuit. (of the place toward which the tail was extended) are folded into the column headings. Each year's rows are headed by a row giving the year and, in the two latitude columns, Boreal. (north) or Auſtr. (south); in 1652 the latitudes are southern for the first two rows and northern thereafter. The hours are as printed: v. (in the evening, vesperi), m. (in the morning, mane), Veſp. (evening); an empty Hours cell is empty on the page. Figures are degrees and minutes, the zodiacal sign printed after the minutes where the page sets one; for 1607 the Sun's longitude carries a sign only on the first row. The names of the stars and places in the sixth column are kept as printed, in their abbreviated Latin: Gr. = degrees; ſup., ſuper., ſupra, ſupr. = above or upper; inf. = lower; præc. = preceding; ſeq., ſequ. = following; Auſt. = southern; cor., corn. = horn; Pegaſi = of Pegasus; Equul. = of Equuleus; Androm. = of Andromeda; Perſei, Perſ. = of Perseus; Med. = of Medusa; Bootis = of Boötes; Cor. = of the Crown; Oph. = of Ophiuchus; Vrſæ, Vrſ. = of the Bear; Arcturi = of Arcturus; Arct. is left unexpanded; Orion. = of Orion; Erid. = in Eridanus; * = the star. On 7 December 1618 the words (Bor. ♍ and on 30 December 1652 the word (Perſ. are printed at the end of the cell as the completion of the name in the row above; on 9 and 28 December 1618 the name runs onto a second printed line, joined here. In the last column A. and B. are the page's letters; in 1577 A. is printed only on the first row of each ruled group of days.

[Margin: Quâ ratione cauda Cometæ 1577 deviaverit.] *How the tail of the comet of 1577 deviated.*

The comet of the year 1590 likewise stayed in northern latitude for its whole duration; yet the inclination of its tail was not always southern, as in the earlier comet. At the start, from 23 February to the 26th of the same month, it was northern, pointing upward from the ecliptic; but from the 26th to 1 March it showed a southern extension, toward the ecliptic. The greatest was 6° 12′, and the least 1° 46′.

[Margin: Protenſio caudæ, Cometæ 1590.] *The extension of the tail of the comet of 1590.*

As for the comet of the year 1618, the inclination of its tail changed from day to day: now it decreased, now it grew to 13 and 20 degrees; and sometimes it was so slight that the tail pointed in an entirely straight line away from the Sun. Here I would have you note that at the start, while the comet was in northern latitude, the deviation was southern, toward the ecliptic, and that it decreased continuously up to 8 December. On the first of December it was 13°; on the 8th of the same month it amounted to only 7′. From that time, however, it grew straight on, up to 7 January, to a magnitude of 21° 28′; and besides, it was observed to be northern, pointing toward the north and moving away from the ecliptic.

[Margin: Cometæ1618.] *The comet of 1618.*

The inclination of the comet of the year 1647 was found to be only 16′.

[Margin: Cometæ 1647.] *The comet of 1647.*

Again, in the comet of the year 1652 [the tail] showed a very conspicuous deviation. On 20 December, when the comet was still moving below the ecliptic, the deviation was southern, declining toward the ecliptic. On 23 December, with the comet lying directly beneath the ecliptic, there was almost no deviation of the tail. But afterwards, from 23 December, when it had crossed the ecliptic, the comet held a southern inclination up to 30 December, downward toward the ecliptic; and on 3 January the deviation became northern again. Just as this variation of its inclination is certainly very notable, so it will give occasion to investigate the matter more thoroughly, especially since the deviation vanished entirely near the ecliptic.

[Margin: Cometæ 1652. Deviatio caudæ bene notabilis.] *The comet of 1652. A quite notable deviation of the tail.*

Indeed, if we examine each of these six comets strictly, we find that the inclination, after the manner of the bodies that make up the head, is bound by no fixed laws; and that in either latitude of the comet the deviation now, toward the ecliptic,

[Margin: Num deviatio caudarum ad certas leges adſtringi poſsit[[,/.]]] *Whether the deviation of the tails can be bound to fixed laws.*

inclines, now moves away from it, increasing and decreasing, now faster, now more slowly, with no account at all taken of the motion; yet in such a way that we may suppose it never exceeds 22°.

But if we wish to settle the dispute solely from the comets of 1577, 1607 and 1652, it seems that we can in some way bring the deviation of the tail from the straight path to a fixed rule and to regularity — on this express condition, however, that we pass over entirely the first and the last observation of the comet of the year 1652. Then, when the comet is near the ecliptic and has no latitude, the tail lacks all deviation entirely and runs directly opposite the Sun, as we clearly learned from our comet observed on 23 December. But when the comet is in southern latitude below the ecliptic, the deviation is always northern and inclines toward the ecliptic. Conversely, when the comet moves in the northern region above the ecliptic, the inclination is southern and likewise points toward the ecliptic, although in its increase and decrease it undergoes various irregular changes, as appeared in those two comets of the years 1577 and 1607.

[Margin: Quando caudæ omninò in oppoſitum Solis exporrigantur.] *When the tails are extended entirely opposite the Sun.*

Kepler's observation of the comet of the year 1618 seems to confirm this very point: only its tail came into view and above the horizon, as the same author reports on pages 53 and 54 of the Histor. Com. For this comet was southern, and it bent its tail toward the north and the ecliptic, that is, it curved the point of its tail. So I consider it not absurd that this may also happen more often in other comets, since this phenomenon also rests on reasons that are not altogether to be dismissed, as can be shown without difficulty by this diagram.

Diagram. An engraved figure set in the text. At the right is a radiant Sun lettered A. To the left stand three circles one above another, each hatched with vertical lines and holding several small hatched ovals; the upper circle is lettered D above and f below at its right, the middle circle C above, and the lower circle g above and E below. Bundles of straight lines run from the Sun through each circle and converge at a point on the left, each such point marked i; B stands at the left end of the middle bundle, beside its i. A single line runs from S at the upper left down to the upper circle, and another from L at the lower left up to the lower circle. Inside the middle circle, among the hatching, stand two small italic letters, m and n. At the lower right is the engraver's signature, Autor ſculps. (Engraved by the author).

- A (right, centre of the Sun): A
- B (left, end of the middle bundle): B
- C (above the middle circle): C
- D (above the upper circle): D
- E (below the lower circle): E
- f (below the upper circle, at its right): f
- g (above the lower circle): g
- i (three times: the convergence points of the upper, middle and lower bundles): i
- m (upper right, inside the middle circle): m
- n (lower, inside the middle circle): n

- S (upper left, end of the line to the upper circle): S
- L (lower left, end of the line to the lower circle): L
- Signature (lower right): Autor ſculps.

In this figure let A be the Sun, A B the ecliptic, and C E D the comet with its nuclei in different positions: at C let it be on the ecliptic, at E southern, and at D northern. Now I say that the greatest part of the Sun's rays falls on the northern comet D and its bodies from the inner side f; hence these rays, too, from the inner surfaces of those bodies and nuclei, the surfaces turned toward the ecliptic,

[Margin: Videtur, pro [[c/e]]ujusvis Cometæ latitudine, porrectiones [[c/e]]audæ deviare.] *The extensions of the tail [?] seem to deviate according to the latitude of any [?] comet.*

according to the law of the angle of incidence and reflection, are reflected; so that all these reflected rays necessarily proceed toward the ecliptic B (departing from the straight path A D S), and for that reason a southern deviation arises, declining toward the ecliptic. For although some of the Sun's rays also strike, upward, the surfaces of the bodies turned away from the ecliptic, and are also reflected from them in another direction, yet because these rays cannot be so joined together and gathered into a bundle, much less meet crosswise, but are scattered in every direction, they are therefore not seen there. But the rays that fall on the inner surfaces and tend roughly toward the part opposite the Sun are for the most part gathered into a heap, as it were, and cross at a certain place. Moreover, all these rays, passing refracted through the rarer matter intermixed with the bodies, are also cast toward the same region; and while they all fly together into one heap, as it were, they grow into a notable mass, so that the tail can be seen very well with a certain southern inclination toward the ecliptic.

When the comet holds a southern latitude, as at E, the solar rays proceeding from A likewise strike the inner surfaces of the bodies at g; so that, again by reason of the angle of incidence and reflection, those solar rays must incline toward the ecliptic B, deviating, that is, from the straight line A L drawn from the Sun through the comet. For even if some rays perhaps pass straight through the comet's body, yet since they are a very small part, they therefore escape all the keenness of the eyes.

Again, when the comet is near the ecliptic, as at C, not only are very many unrefracted rays carried across to B through the thinner matter intermixed with the bodies of the head, but the rays reflected from the surfaces of the more northern bodies are also cast toward the ecliptic B, no less than those that strike the inner surfaces of the more southern bodies; so that in that position the tail necessarily proceeds entirely in a straight line from the Sun, and hardly declines to either side.

[Margin: Cometâ circa Eclipticam verſante, cur cauda parùm admodum declinet.] *Why, when the comet lies near the ecliptic, the tail declines very little.*

And this, such as it is, is our view of why it should be presumed that the tail, when the comet moves under the ecliptic, deviates to no side but proceeds

along a straight path with respect to the Sun; why, when the comet is northern, the inclination of the tail is southern and at the same time verges toward the ecliptic; and finally, when the comet is southern, from what source a northern deviation, likewise toward the ecliptic, arises — as the observations of three comets clearly show. In what way, moreover, the comet of the year 1652 deviated its tail at every time it was observed is gathered from the following figure. In it we have wished to draw, as far as could be done, the inclination of the tail for the place of the Sun and of the comet. Let S, therefore, be the Sun, D S E the ecliptic, C the comet observed at different times, and h i the inclination from the straight line S C i drawn from the Sun through the head of the comet.

[Margin: Quomodo Cometa 1652, toto durationis tempore caudam deviaverit.] *How the comet of 1652 deviated its tail over the whole time of its duration.*

Now although the comets observed in the years 1577, 1607, and 1618 and 1652 seem in some measure to establish this matter, nevertheless I do not wish to assert it so doggedly, as if it must always happen thus and not otherwise in any comets whatever that appear — this being especially considered, that all and each of the observations of comets by no means prove it, although to reason

[Margin: Vt ut ſatis plauſibilis hæ[[c/e]] hypotheſis eſſe videatur; tamen nihil certi de eâ adhuc ſtatuendum eſt.] *Although this [?] hypothesis seems plausible enough, nothing certain is yet to be established about it.*

it is not altogether contrary. Besides, since only very few observations are available by which this matter could be established, I therefore consider it wrong to determine anything certain about all [comets] in general. Meanwhile, however, it seems reasonable that this deviation is for the most part so constituted, especially when comets move at an obtuse angle of the orbit and the ecliptic, and traverse in their orbit a fairly large space toward the north or the south.

Diagram. An engraved figure set in the text between the third and fourth lines. A large circle with a horizontal diameter from A at the left to B at the right. The Sun, a small rayed circle lettered S, stands in the lower left quadrant; a straight line runs from S down to d on the circle at the lower left, and from S a fan of straight lines rises to the right to the circumference in the upper right, six of them ending at points marked i. The word Ecliptica (Ecliptic) is written along one of these lines. A straight line crosses the upper part of the circle from f at the upper left to g at the lower right, inscribed Orbita near f and Cometæ near g (together, Orbit of the comet); on it stand six comet heads, each with a small c beside it and a tail drawn up and to the right, ending at a letter h. At the lower right is the engraver's signature, Autor ſculps. (Engraved by the author).

- f (upper left, on the circle, at the start of the orbit line): f
- Orbita (along the orbit line next to f): Orbit
- i (six times, on the circumference at the upper right, at the ends of the lines from S): i

- h (six times, at the ends of the six tails; the uppermost on the circle): h
- c (six times, beside the six comet heads): c
- Ecliptica. (along one of the lines rising from S): Ecliptic
- A (left end of the horizontal diameter): A
- B (right end of the horizontal diameter): B
- Cometæ. (along the orbit line next to g, reading downward): of the comet
- g (lower right, on the circle, at the end of the orbit line): g
- S (above the Sun): S
- d (lower left, on the circle, at the end of the line from S): d
- Signature (lower right): Autor ſculps.

Otherwise, if the comet crossed the ecliptic in its orbit at a more acute angle, toward the east or the west, and if in addition a singular constitution and disposition of the bodies of which the head is otherwise composed were present, so that a certain peculiar refraction and reflection of the rays arose — on that condition I readily grant that the deviation of the tail can also behave quite otherwise, and indeed that this inclination might verge entirely the opposite way. This also happened in the comet of 1590, which moved almost along the course of the ecliptic: for in northern latitude it showed both a northern and a southern inclination of the tail. From this it is clear that in the same latitude [a comet] can have a different deviation, now greater, now smaller, and sometimes show, as it were, a reciprocal motion of inclination. This very thing can likewise be further confirmed by the comet of the year 1618, but above all by the comet of the year 1596, which shone near Ursa Major — that is, in the northern region — on 9 July. Of it Kepler says this in *Part. Opt.* Chap. VI, page 67: *The tail at first declined to the right, then coincided with the very diameter of the Sun, and finally passed over to the left.* From all of which it is abundantly clear that the deviation of the tail,

[Margin: In quibusdam Cometis reciprocus quaſi motus inclinationis animadverſus eſt.] *In some comets a reciprocal motion, as it were, of the inclination has been observed.*

[Margin: Quinam Cometæ omnem æqualitatem exuere videantur.] *Which comets seem to cast off all uniformity.*

is not so strictly subject to fixed laws, but that this inclination can often change in various ways, when the disposition of the comet's body is altered — as regards both the denser parts and nuclei and the thinner matter lying between them — or according to the relation of the comet's position to the Sun, and of its proper motion.

Finally, it must also be carefully noted that this inclination or deviation of the tail from that great circle drawn from the Sun through the head of the comet — if we look into the matter somewhat more deeply — occurs not only toward the north and the south, according to latitude, but also according to longitude, that is, toward the east and the west; indeed in every direction, toward any

region of the aether whatever, spherically, as will easily be evident to each and every one who weighs this matter duly.

[Margin: Caudæ Cometarum tam ſecundum longitudinem,quàm latitudinem exorbitant.] *The tails of comets deviate according to longitude as well as according to latitude.*

I go further and inquire from what source the curvature of the tail arises — a curvature that was very conspicuous in a great many comets: it occurred, for example, in the time of Xerxes, in the year 480 before the birth of Christ; likewise after the birth of Christ, in the year 1099, in the year 1577, and in the year 1618, to say nothing of the rest. These comets appeared curved like a horn or a scimitar, and for that reason were also called Ceratiae. This question has certainly also given philosophers much trouble, so that they could scarcely meet thoroughly every difficulty and objection. Tycho, who was almost the first to begin investigating this matter, and whom Blancanus and very many others afterward followed, holds (Book II *de Com.*, Chap. VII) that the bending — namely, of the comet of the year 1577 — did not really exist in the heavens, but that its tail appeared so curved through some chance accident, either because of an aberration of sight or because of parallax, since the extremity of the tail was much nearer to us than its beginning, which adheres to the head itself. He tries to demonstrate this from Vitellio, Book VII, Theorem 31, and from Ibn al-Haytham, Book II, Proposition 28, and from Joh. Pisanus. But in my judgment there is little strength in these reasons. For at so great a distance anything oblique and curved would rather appear straight, as is evident in the Sun and the Moon: although they are spherical bodies, they are seen nonetheless just like a disc. Next, the tail is not curved for the reason that its extremity was nearer the Earth than the head itself, as Tycho will have it. For on that reckoning, all comets whose tail-end was farther from the Earth than the head itself would by no means be curved. Yet the point of the tail of the comet of the year 1618 (and there have doubtless been very many of that kind), although it was much more remote from the Earth than the head itself, nevertheless appeared remarkably curved. If, however, a comet were to pass between the Earth and the Moon with its tail stretched out toward us, where parallax and refraction could exert their force, then indeed, I admit, the tail would become curved to some extent — but nowhere except near the horizon, in a lower position of the comet. For near the meridian, in a somewhat higher position, it would in turn appear straighter. But in comets that move with curved tails the case is found to be otherwise, and they never undergo such changes. For those that are arched when lower, near the horizon, are seen elsewhere too, and constantly in every higher position — on the same day, that is — with a quite similar appearance; to pass over other reasons for which that Tychonic opinion can rightly be rejected.

[Margin: Vnde Caudæ incurventur?] *From what source are the tails curved?*

[Margin: Tychonis hâc de re ſententia.] *Tycho's opinion on this matter.*

[Margin: Quare ſententia hæc meritò rejiciatur.] *Why this opinion is rightly rejected.*

Others, such as Galileo, Guiduccius, Cysat and Gassendi, assert that the tails of comets are in fact entirely straight, and appear curved only because of the refraction that takes place in the convexity of the vaporous air — namely, when they relate the tail as inclined toward the horizon. But this reason is not of any weight either, since on this reckoning all the longer tails near the horizon would shine with a bent-back appearance. Experience, however, flatly contradicts this: for many comets, such as the Javelin-shaped [comets], which shone with very long rays and hair, have been observed with entirely straight tails in lower positions.

[Margin: Nonnullis placet ob refractionem tantummodò caudas incurvari.] *Some hold that the tails are curved only because of refraction.*

Second, according to that opinion the tails would be curved only up to the 20th degree of altitude, as far as the refraction of the air otherwise extends; in higher places, where refraction would cease, they would point entirely straight. Yet, as we said just now, in every position — as was likewise observed in the comet of the year 1618 — they always show a similar curvature and obliquity of the tail to all the inhabitants of the Earth living under one curve of the heavens or another, to whom it merely comes into view, however much the same comet may be lower for some and, again, higher for others. Indeed, if we believe Cysat, the exact opposite was noticed in the comet mentioned above: namely that, when lower, near its rising, within the refraction, it appeared with a straight tail, but when higher, at the meridian, outside the refraction, with a bent tail. For he says in Chap. IV, page 62: *The same night, two hours later, around 11^h at night, the head of the comet also began to appear, having struggled out of the vapours, at an altitude of 3°, the course of the tail still being straight; afterward, in the morning, around 7^h, near the zenith, this course was curved with a very great bend. This was also noticed thereafter, and indeed already before as well: namely, that the tail of the comet stretched out almost along a straight line near its rising, but at the meridian, whether the comet was at its highest or at its lowest, was bent and curved to the greatest degree.*

[Margin: Nec hæc ratio vim aliquam obtinet.] *Nor does this reason have any force.*

[Margin: Incurvatio [[c/e]]audæ, Cometæ 1618.] *Curvature of the tail [?] of the comet of 1618.*

Third, it would also be necessary for the tails always to be curved upward, if the obliquity arose from the refraction of the air; for refraction raises and lifts everything. Yet in very many comets the very opposite has been found: namely, that they are bent obliquely downward.

[Margin: Ex refractione Caudæ ſemper ſurſum incurvarentur.] *From refraction, tails would always be curved upward.*

Fourth and last, to be brief: that opinion cannot stand for this reason either, that all refraction could make the tails curve scarcely more than half a degree,

and that only upward; and this curvature would both be perceived, to be sure, only with effort, and be wholly unstable and diminishing, because refraction lessens with each degree of altitude, if a body ascends. Now it is placed beyond all hazard of doubt that there have been not a few comets whose tail curvature not only exceeded half a degree but reached several whole degrees, and which moreover was found supremely constant in every position over very many days. Therefore this curvature of tails by no means arises from the bare and sole refraction of the air of our atmosphere; which was to be proved.

[Margin: Nec ultra ſemigradum; cùm tamen obſervationes contrarium evincant.] *Nor beyond half a degree; whereas observations prove the contrary.*

Therefore other reasons must necessarily be supplied for the source from which that curvature of the tail takes its origin; and effort must be given to demonstrate duly, at the same time, in what way it is brought about. I am, however, fully convinced that this curvature of the tail in no re-

[Margin: Curvatura caudarum non eſt apparens, ſed realis.] *The curvature of tails is not apparent but real.*

spect is apparent, by reason of parallax or of the refraction of our vaporous sphere, but is truly real. It arises partly from the reflection and refraction of the solar rays that take place in the head of the comet, and partly, at times, from some singular and special refraction of those rays supervening on it, which is produced by the rather rarefied matter adhering to the comet. According to the size of the angle of inclination of the reflected and refracted rays, and according to the various degrees of rarity and density, increasing and decreasing, of the matter adhering to the head, the tail is bent now upward, now downward, more or less, in keeping with the tenor of all these things.

These things, indeed, have been said easily and briefly; but they are certainly not equally easy to understand, much less to demonstrate: by what path, namely, is the curvature of tails produced? I therefore consider it supremely necessary that this quite arduous matter be explained clearly, and demonstrated, at length and point by point, not only in words and reasons but also in diagrams, so that, if not absolutely everyone, at least those who are wise beyond the common measure and have penetrated the foundations of optics may not be unable to understand this business correctly. For I think that by someone wholly unschooled in optical matters each and every point will be grasped only with great difficulty, however clearly the things are proposed, set out and demonstrated.

[Margin: Non res leviuſcula eſt, rationes incurvationis Caudarum rectè penetrare.] *It is no slight matter to penetrate correctly the reasons for the curvature of tails.*

To begin, then: in our opinion the tails of comets are bent and curved in two ways, by reason of the rarer matter adhering to the comet. First, by straight rays; and then also by oblique and curved rays, refracted in various ways in that matter just mentioned, or in finer evaporations. For the first way, when curvature is induced in tails by straight rays, only two things are required: namely, that the rather rarefied matter surrounding the comet — that cometary

atmosphere, as it were — be uniform and free of differing degrees both of density and of rarity; and second, that the head of the comet, by reason of the nuclei of the intermixed, thinner matter, be so composed that the solar rays, reflected and refracted and passed through the head, cross immediately below the head and at points nearer to it, as we sketched at B in the Figure inserted above at page 483. In such comets the tail is always rendered narrower near the head than in the middle and at the end, like the comet of the year 1618. With these things supposed, then, in comets of that kind the curvature and obliquity of the tail is produced by entirely straight solar rays, so that the tail takes on a convexity on one side, while on the other it presents itself to be seen with an appearance either stretched out or partly concave: the very aspect in which the comet of the year 1618 was observed and drawn under designations 44 and 45, attached at page 452.

[Margin: Autoris ſententia, quomodo obliquitas & curvitas caudis inducatur.] *The author's opinion: how obliquity and curvature are induced in tails.*

This I shall explain and demonstrate almost far more readily and clearly by the two following diagrams, and by lines, than by long-drawn-out words anxiously sought out. In these, each head is supposed to be so constituted that it can refract and strike back the solar rays passed through it in such a way that, on going out, they intersect one another crosswise near the head itself; and further, that the rather rarefied matter surrounding the head, in which the rays must be stopped and held fast, is uniform and of the same rarity and density: for in such a medium all rays, as is established from optics, proceed unrefracted. And then it can certainly come about, according, that is, to the constitution of the head, the position and shape of the bodies, the surface, and their inclination,

[Margin: Mens Autoris Iconiſmis clariùs detegitur : quâ ratione per radios rectos caudæ incurvari poſſint.] *The author's meaning is disclosed more clearly in figures: in what way tails can be curved by straight rays.*

that some rays are drawn out more and others less; that is, that some are longer, or shorter, than others. Indeed, it also seems reasonable that rays refracted only in the head can be stronger and more vivid, and consequently also be drawn out farther, than those that pass through at once refracted and struck back. For these are, as it were, weakened by that double action, so that they become shorter than the rest and vanish more quickly. For whatever is reflected and reverberated by a more solid body loses something of its impetus and motion.

Diagram. An engraved figure set between the paragraphs: three comets one above another, each with a hatched round head surrounded by a stippled coma and a tail of fine lines streaming to the right. The top and middle tails each end at a point labelled E; the bottom tail carries no end label. The engraver's signature stands at the lower right. All fifteen labels on the figure were read.

- A (above the top head): A
- d (above the neck of the top comet): d
- C (left of the top head): C

- f (upper edge of the top tail, toward its right end): f
- E (tip of the top tail): E
- d (below the neck of the top comet): d
- B (above the middle head): B
- d (above the neck of the middle comet): d
- C (left of the middle head): C
- E (tip of the middle tail): E
- d (below the neck of the middle comet): d
- G (above the bottom head): G
- C (left of the bottom head): C
- f (upper edge of the bottom tail, about a third of its length from the head): f
- Signature (lower right): Aut. ſculps. — *Engraved by the author.*

If, then, straight [lines] are drawn through the head of the comet in such a way that the intermediate ones, as being only refracted, are the longer ones, C E, while the rest, at once reverberated and refracted, are shorter the nearer they are to the head, in keeping with those most diverse angles of incidence and reflection, as can be seen at f, so that all of them cross beneath the head itself at d: then, I say, the tail takes on a convexity on one side or the other, namely on the side toward which most of the lateral rays, refracted and reflected, are projected, that is, at f. Thus in Figure A you have a comet which shows a convexity on its upper part and a certain concavity on its lower side; in the other Figure, B, however, one that displays an entirely inverted appearance. From these images it is now clearly evident that some curvature can be produced in tails even by straight lines or rays, with every other, different refraction and reflection of the rays set aside: namely, when on one side of the head a greater refraction and reflection of the rays occurs than on the other. This, beyond all doubt, happened in the comet of the year 1618, since it showed almost the same appearance as we have just drawn. For from the first to the middle of December it swelled on the upper side, but afterwards, right up to the end of its appearance, on the lower side; Cysat is the authority for this.

[Margin: Quâ ratione caudæ convexitatem aliquam induant.] *In what way tails take on some convexity.*

But if the angles of the incident solar rays, refracted and struck back, were nearly equal on both sides of the comet's head, and at d, the point of intersection, the tails would certainly be seen not with a curved appearance but convex on both sides, that is, wider in the middle than near the head — after the example of that hairy star observed in the year 1569, which we have given drawn under Figure 21 at page 444, and here under the letter G. And so in this way, in some comets that display a not very prominent concavity, the curvature of the tails can very well be accounted for, however much the convexity may rise and the tail swell, whether it be pointed, or dispersed and spread apart.

But when tails are so curved that the concavity corresponds to the convexity and is equal to it, or even somewhat greater, whether, now, pyramidal ones occur,

[Margin: Non omnis curvatura, eo modo, per radios rectos falvatur.] *Not every curvature is accounted for in this way, by straight rays.*

or ones dilated about the extremity, or more compressed at the head and more extended in the middle: then, certainly, on the foundation laid above the matter by no means turns out so easily, but involves more difficulty and labour. For, in addition, other refractions and reflections, besides those that take place in the head of the comet, intrude themselves outside the head by reason of the thinner matter lying hidden behind the comet, as will soon be shown more clearly. For the sake of better understanding, however, it will help to set out first one or another optical and catoptrical axiom, so that we may penetrate this business all the more correctly.

1. All rays that fall on the surface of any transparent body [diaphanum], whether rarer or denser, perpendicularly, or at right angles, remain unrefracted and pass through. Conversely, if they fall at oblique angles, they are broken at the points of incidence and inclination; and the more obliquely they fall, the greater the angle at which they are refracted. Vitell. Book II, props. 42, 43; and Maurolycus [Francesco Maurolico], Book I, page 36, *On Light and Shadow*.

[Margin: Axiomata Optica de radiorum refractione.] *Optical axioms on the refraction of rays.*

2. And indeed rays are refracted toward the perpendicular if they fall from a rarer medium into a denser one; but if they pass from a denser into a rarer one, they are refracted away from the perpendicular. Vitell. Book II, props. 45 and 47; Ibn al-Haytham, Book VIII, no. 8; Kepler, in the *Dioptrice*, axiom 2; Aguilon. Book II, prop. 8; Scheiner, *Rosa Ursina*, Book IV, prop. 1, ch. 23; and in the *Oculus*, Book I, part I, ch. 3. The perpendicular toward which, or away from which, refraction takes place is the line that stands at right angles on the surface of the medium, or of the second transparent body, from the point of incidence. Hence it follows that as often as rays terminate in different transparent bodies, so often does a refraction of the rays take place that differs each time, provided, that is, that they fall obliquely on those surfaces; as I myself also demonstrated at greater length in the Prolegomena to the *Selenographia*, Chap. II, page 19, and likewise Chap. VII, page 194.

With these things set out first, I think it should now at the same time be briefly recalled to memory what we derived at length above, at pages 464 and 484: namely, that tails are not tied to the exact opposition of the Sun but deflect in various ways, now to the south, now to the north, from that arc of a great circle drawn from the Sun through the head of the comet. We showed this in certain comets, namely those observed in the years 1577 and 1652; and above all in the latter: that while it stood below the ecliptic, in southern latitude, its

tail inclined upward toward the ecliptic; that as the comet proceeded under the ecliptic, almost all deviation vanished; and that again, in northern latitude, a southern inclination toward the ecliptic was detected. Besides this, we added in the same place that, although it is indeed credible that this very phenomenon happens no differently in many comets, it is nevertheless not common to each and every one. Accordingly, it is certain and beyond doubt that in all comets, in whatever places of the heavens they stand, such an inclination of the tail is altogether present, either sometimes regular or sometimes even extremely irregular, while they project their tails in every direction, now toward the south, now toward the north, deflecting more or less from the [point] opposite the Sun, according to the constitution of the head and the reflection and refraction of the solar rays.

[Margin: Protenſio caudæ ad punctum Solis oppoſitum non omnino adſtringitur, ſed ſæpius ad latera deviat.] *The extension of the tail is not wholly bound to the point opposite the Sun, but more often deviates to the sides.*

Now I say, and let it be well noted, as will also be properly demonstrated later, that absolutely no notable curvature of the tail, convex, that is, on one side and concave on the other, appears where not at the same time some, of the tail or of the ra-

[Margin: Nulla curvatura absq́; inclinatione caudæ datur; niſi in certis quibusdam Cometis.] *No curvature occurs without an inclination of the tail, except in certain particular comets.*

ys of the Sun, inclination occurs, so that the tail deviates a little, to this side or to that, from that straight line running from the Sun to the point opposite it. For where there is no deviation, there the tail tends toward the region turned wholly away from the Sun. But I would have you except those comets that show a convexity on one side and a nearly straight line on the other, as happened in the comet of the year 1618: in these, I say, no inclination is needed.

When, therefore, such an inclination befalls a comet, then a certain curvature and obliquity can certainly be induced in the tails; but with that deviation removed, by no means. Yet it does not follow, meanwhile, that when an inclination is present in the tail, the tail must then also be bent and curved, as will be shown in its place. I assert only this: that tails are certainly never curved without some inclination; indeed, if a comet is wholly free of all such inclination, one labours in vain at demonstrating that phenomenon. Moreover, we also lay down that a thinner matter adheres to comets, in which the solar rays passing through are fixed and stopped, but one that has quite different degrees of density and rarity; otherwise, certainly, even if an inclination is present, no curvature of the tail emerges. For otherwise all the rays break straight through that posterior medium, so that the tails necessarily shine out straight.

[Margin: Datâ verò inclinatione caudæ, non datur ſimul incurvatio.] *But where an inclination of the tail is given, a curvature is not given along with it.*

[Margin: Materia illa tenuior,quæCometis adhæret, diverſos gradus denſitatis & raritatis poſſidet.] *That thinner matter which adheres to comets possesses different degrees of density and rarity.*

But you may perhaps ask what proportion of rarity and density in the thinner matter adhering to the comet is required to produce curvature in the tails? I say that any matter, of whatever condition it may be, suffices for that purpose and can bend and curve the tails: whether, beginning from the head, it is somewhat denser and thicker and becomes gradually subtler right up to the end, until it vanishes entirely; or whether it is thinner at the head and grows in density; or whether, finally, it is mixed in many ways, at intervals, of density and thinness, so that it is thinner in the middle than at the beginning and the end, or the reverse. There will be only this difference: that the curvature will not always come out of one kind and like itself at every time, but quite different and varied, according to those different degrees of rarity and density, and also by reason of the order that the density and rarity of the matter hold at that time.

[Margin: Num certa proportio denſitatis & raritatis,materiæ dilutioris, ad incurvatas caudas exhibendas,requiratur?] *Whether a definite proportion of density and rarity in the thinner matter is required to display curved tails?*

[Margin: Pro diverſitate materiæ Cometam concomitantis,curvatura, & obliquitas caudæ variatur.] *The curvature and obliquity of the tail vary according to the diversity of the matter accompanying the comet.*

It is credible, however, that this rather rarefied matter standing by the head usually becomes successively thinner, starting from the head, until it passes off into the pure and most subtle ethereal air. This is easy to demonstrate from the spots. For if they are surrounded by faculae, by shadows, and by a certain thinner matter, or a kind of halo, as usually happens for the most part with the larger spots, then, certainly, the farther that matter recedes from the principal body, or spot, the more it is attenuated; likewise the faculae and shadows are the thinner the more remotely they stand, until, in a more remote place, that is, they wholly escape the gaze of the eyes and are entirely dissipated. Next, just as in the very centre of the comet's head the largest nuclei of all, and denser matter, are usually seen, but toward the edges subtler matter, so too it is not unfitting that the farther the thinner matter stands from the body of the comet, the rarer and thinner it should also be.

[Margin: Materiam Cometæ adhærentem remotiorem, propiore eſſè ſubtiliorem.] *That the matter adhering to the comet is subtler when more remote than when nearer.*

Our atmosphere likewise seems to confirm this: for vapours and exhalations are certainly the thicker the nearer they are to the Earth; and again, the more remote they are,

[Margin: Atmoſphæra Cometica imitatur Atmoſphæram Terreſtrem.] *The cometary atmosphere imitates the terrestrial atmosphere.*

the subtler. So now, too, I have no doubt that the same holds for the vaporous orbs of the ethereal bodies. Moreover, since this rarer matter surrounding the

comet is nothing but a certain cometary atmosphere, which is composed of those rather rarefied leftover evaporations of the planets that are not very apt for condensation, it is therefore not incongruous either that this matter should be the thinner and more fluid the farther it is from its body, or centre, and that its density should usually decrease.

Meanwhile, however, I do not altogether deny that the said matter can sometimes also grow in density, either in the middle, or gradually, beginning from the head. For it can certainly happen that some denser matter, while the comet is carried across the ether, accrues at its extremity, or on one side or the other, matter that is not given to reach the head equally conveniently. Whatever the case in this respect, nothing at all is taken away from this business of ours, or hypothesis, except that the curvature takes on now one figure and section, now another; so that, while the matter decreases in density from the head itself, the curvature presents a convexity upward, and again, when the matter increases in density, a convexity downward, and so shows an inverted face.

[Margin: Materia denſitate decreſcens convexitatem ſurſum; creſcens verò curvaturam deorſum inducit.] *Matter decreasing in density induces a convexity upward; increasing, however, a curvature downward.*

Therefore, with a solid foundation laid for this speculation of ours on the curving of tails, let us now approach the demonstration itself, and derive accurately, through various figures and lines, in what way that real curvature of the tails arises. First, we shall set up the demonstration as if the thinner matter girding the comet displayed decreasing degrees of density, beginning from the head, as usually happens with comets. Afterwards, however, let us show what difference there is when that thinner matter following after displays various increasing degrees of density; and we have also proposed to bring forward other matters that will seem to bear on this.

[Margin: Quâ ratione realis caudæ curvitas demonſtretur.] *In what way the real curvature of the tail is demonstrated.*

In the following Figure we have first drawn three comets. The tail of the first, under number I, points straight ahead; the tail of the second, at number IV, swells on its upper side, with its tip descending toward the south; while the third, under number V, stretches the concavity of its tail upward toward the zenith, with its point likewise ascending toward the north. In each diagram let A be the Sun, C the head of the comet, S T A the ecliptic; and let the medium, or that matter beside the comet, be so disposed that from the head right to the end, at each circle D, G, H, I, K, L, M, etc., it shows different degrees of density decreasing, or of rarity increasing. In the first diagram I show the comet as if it were moving in the ecliptic, or in a place where it is wholly free of all inclination, as happened with the comet of 1652, and also with the comet of the year 1618 on certain days, especially December 9 and 10. In such a position, I say, whether that rather rarefied matter surrounding the comet has different degrees either of density or of rarity, as in the drawing, or is also wholly even

and uniform, the comet's tail extends in nothing but an entirely straight line; and indeed it now ends in a sharpened point, now shines with spread-out rays. This difference, however, we do not attend to here, since it takes its origin from another cause, as has already been touched on above and perhaps will also be shown more fully below.

[Margin: Elucidatio Iconiſmorum.] *Explanation of the figures.*

[Margin: In priori Schemate,Cometam in Eclipticâ verſari,ſupponitur.] *In the first diagram the comet is supposed to be moving in the ecliptic.*

And from this, indeed, the tail appears entirely straight. For all the rays penetrate through the middle of the head straight and perpendicularly, without any inclination and consequently without refraction too, according to that earlier axiom: All rays falling perpendicularly on the surface of any transparent body, whether rarer or denser, remain unrefracted. These rays, therefore, are projected in this way without refraction as far as they can reach, and as they are usually stronger and more vivid, so they are also longer, forming the point B. With the remaining solar rays, which pass across either side of the comet, the case is almost the same, because the Sun is larger than the body of the comet itself, so that nearly all of them are parallel and equidistant.

[Margin: Quando Cometarum cauda recta videatur.] *When the tail of comets appears straight.*

And although some sensible refraction of the rays occurs in the collateral parts of the comet's head, and also in the thinner matter attached to the comet, if it is of different density (since not every single ray is driven through as directly as indeed those around the middle are), they will nevertheless contribute very little to this business, except that they make the tail either somewhat more pointed or more spread out. For all the rays that can be refracted, while they fall from the Sun out of some rarer medium onto the comet as into a denser one, are indeed refracted toward the perpendicular, but only for as long as they remain in the head of the comet. When they leave the head again, however, passing as from a denser medium into a rarer one lying hidden behind the comet, the rays are refracted back away from the perpendicular F E: for example, the rays in the more northerly parts of the comet are driven downward, toward the intermediate line B and those unrefracted rays; likewise, in the more southerly parts, they are projected upward from that perpendicular F E toward the said line B.

Perhaps you are persuaded that in this way the tail must be curved to some degree? But since all the intermediate rays remain straight, and the collateral ones fly together toward them equally from both sides, that barely perceptible refraction induces no curvature whatever. For as much as the tail rises on one side for that reason, so much does it also swell on the other, so that all bending is thus entirely avoided; except that, as a result, it appears either a little more pointed or spread out at its extremity. This is not very laborious to understand from the two figures 2 and 3 placed here; it can also be seen from those in which the crossing of the rays occurs near the head, which we sketched above under

the letter G. For this reason, then, and in this way, although the transparent medium behind the comet is of different density, while the solar rays are free from all inclination and penetrate the comet's head unrefracted, the tail can be seen only as stretched out entirely straight, although with its hairs sometimes more, sometimes less scattered and shaggy.

[Margin: Etiamſi diaphanum poſt Cometam hærens diverſæ ſit denſitatis, poteſt tamen nonnunquam Coma in directum omnino protrudi.] *Even if the transparent [medium] adhering behind the comet is of different density, the coma can nevertheless sometimes be thrust out entirely straight.*

But when the comet has some notable inclination of the rays, whether from northern or southern latitude, or from the particular constitution of the nuclei and the matter of which the head is composed (which we discussed abundantly in what precedes); and when, moreover, the comet is enclosed by some thinner matter, or atmosphere, having different degrees of density and rarity, the tail must necessarily be curved, and indeed more or less, according to the size of the inclination and the diversity of the adjacent transparent medium; and then, besides, the tip curves toward the side to which the inclination leans, toward that region, I say.

[Margin: Cometâ notabilem inclinationem, atq́; atmoſphærâ diverſos gradus denſitatis & raritatis obtinentibus, datur caudæ curvitas.] *When the comet has a notable inclination, and an atmosphere having different degrees of density and rarity, a curvature of the tail is given.*

Diagram. A full-page engraved plate, numbered Fig. P. at lower left and signed below it *Autor ſculpsit.* (Engraved by the author). It shows five comets, numbered I to V (the I engraved in its J-form: J, JJ, JJJ, JV, V). The upper diagram (I): the Sun A at left sends three lines to the comet's head, marked *Cometa.* (Comet), with F and C inside the head; a set of concentric arcs opens to the right of the head, lettered D, G, H, I, K, L, M, N, o, P, Q., R along the top of a straight tail whose converging lines meet at B on the right; one line from the head rises to E under *Septentrio.* (North), another descends to E above *Auſtrum.* (South). Comets II and III are drawn below it with spreading, hairy tails and carry no letters. The middle diagram (IV): lines from the lower Sun A rise to the head marked *Cometa.*, with c above the head, a letter inside it [?], and c below; the tail curves downward to the right beneath the arcs lettered D, G, H, I, K, L, M, N, o, P, Q., R; three lines from the head rise to E, B and Y at upper right; *Septentrio* (North) stands above the tail and *Auſtrum.* (South) below it. The lower Sun A serves both lower diagrams; a horizontal line from it is marked *Ecliptica.* (Ecliptic) on its left part, T at the middle and S at its right end. The lower diagram (V): lines from the Sun descend to the head marked *Cometa.*, with c above the head, F inside it and c below; the tail curves upward to the right, with D at its upper edge beside the head and D, G, H, I, K, L, M, N, o, P, Q, R along its lower edge; three lines descend from the head to Y, B and E at lower right; *Septentrio.* (North) stands above the tail and *Auſtrum.* (South) below it.

- I (upper left): J (numeral I)
- I, Sun (left): A
- I, above the head: *Cometa.* (Comet)
- I, inside the head: F (upper), C (lower)
- I, along the tail: D, G, H, I, K, L, M, N, o, P, Q., R
- I, upper right: *Septentrio.* (North), E
- I, tail end (right): B
- I, lower right: E, *Auſtrum.* (South)
- II (left): JJ (numeral II)
- III (left): JJJ (numeral III)
- IV (left): JV (numeral IV)
- IV, above the tail: *Septentrio* (North)
- IV, upper right: E, B, Y
- IV, above the head: *Cometa.* (Comet)
- IV, at the head: c (above), [?] (inside), c (below)
- IV, along the tail: D, G, H, I, K, L, M, N, o, P, Q., R
- IV, below the tail: *Auſtrum.* (South)
- Lower Sun (left, serving IV and V): A
- Horizontal line from the lower Sun: *Ecliptica.* (Ecliptic), T, S
- V (left): V (numeral V)
- V, above the tail: *Septentrio.* (North)
- V, above the head: *Cometa.* (Comet)
- V, at the head: c (above), F (inside), c (below)
- V, upper edge of the tail by the head: D
- V, along the lower edge of the tail: D, G, H, I, K, L, M, N, o, P, Q, R
- V, lower right: Y, B, E
- V, below the tail: *Auſtrum.* (South)
- Lower left: *Fig. P.*
- Below it: *Autor ſculpsit.* (Engraved by the author)

For example, given a southern inclination, as in certain northern comets, there also occurs a concavity of the tail, with the southern point inclining downward; but when the inclination is northern, as in some more southerly comets, the concavity is likewise northern, with the tip inclining upward. But let us clearly demonstrate, from the two attached diagrams 4 and 5, how this curvature of the tail actually arises, and in what way the solar rays are made oblique. And first, indeed, from figure 4, where the tails swell from the north and incline downward.

[Margin: Eam plagam versùs apices caudarum incurveſcunt, in quam inclinationes earum propendent.] *The tips of tails curve toward the region to which their inclinations lean.*

In each drawing, let A be the Sun illuminating the comet C with its rays; F the centre of the comet; C C the bodies composing the head; and the circles D G H I K etc. the diversity of the medium, always decreasing in density, or increasing in rarity. Let the head of comets itself be taken (as has already been

said often in Books VI and VII, and must still be accepted now, as always) for a body not entirely spherical but disc-shaped: flat on both sides, both the side for the most part turned toward the Sun and the side turned away, yet endowed with a certain thickness, according as it abounds in numerous corpuscles and nuclei and in matter.

[Margin: Quâ ratione radii Solares per caput Cometæ trajecti incurventur, Autor demonſtrat.] *The author demonstrates in what way the solar rays that pass through the head of the comet are curved.*

If, then, the rays of the Sun were projected through this disc, namely the head of the comet, without any notable refraction and inclination, they would proceed entirely straight, like rays falling at right angles, which always remain unrefracted: as in the Figure placed here, the ray from A, passing beside the corpuscle C of the head, goes straight on to B.

[Margin: Radius ad angulum rectum incidens, irrefractus pergit.] *A ray falling at a right angle goes on unrefracted.*

But since things happen otherwise when the comet is either in a northern latitude or in such a position that a notable inclination of the rays, refraction, and above all reflection befalls it, the Sun's ray A C B, striking the corpuscle C, or its surface, at a quite notable angle of incidence, or dashing forcefully against it, necessarily acquires a certain inclination and force to carry itself further at the angle of reflection, and to deflect itself from that straight line C B (whose course it would otherwise follow, if that ray persisted unrefracted and unreflected) downward toward the ecliptic and the letter D; at that point it reaches the first circle of that rarer medium adhering to the comet. That is, this ray from the Sun A, advancing through D, the first point of intersection, is refracted away from the perpendicular line, or from the perpendicular A D Y drawn from the Sun. In this place that line is the genuine perpendicular of which those optical and catoptric axioms speak; in other cases, however, the line E D F would truly represent the perpendicular, namely with respect to the circles of the rarer transparent medium, which recognise the comet as their centre, as it were.

But so that you understand the matter rightly, this transparent medium is not to be conceived as if nature herself had set up such circles, which would regard the comet as their centre, but only as a subtler matter spread out and diffused, recognising no centre, like our terrestrial clouds, and the solar shadows and faculae. If, therefore, we take the matter in this way, not the line E D F but A D Y will be the genuine perpendicular: namely, the ray that would pass through D if there were no refraction, reflection and inclination of the rays. Nor can it be otherwise, since it is the rays descending from the Sun that must be considered: if they remain unrefracted and straight, the tail too is straight; but if they are refracted and bent, the tail too is curved, because that curvature is entirely real with respect to the Sun.

[Margin: An atmoſphæra Cometica certos limites denſitatis poſſideat ?] *Whether the cometary atmosphere has definite limits of density.*

From this perpendicular A D Y, or direct and unrefracted ray, the said ray A C now proceeds continuously downward toward the south. For since it is first reflected at C, and is thus led down to D at the angle of reflection, it can in no way tend straight on, by reason of that transparent medium which grows successively rarer, but is necessarily carried obliquely from that point of impact C to D, always receding from this perpendicular.

[Margin: Quomodo radii Solares à perpendiculo refringantur.] *How the solar rays are refracted away from the perpendicular.*

Further, from D as far as G this ray, since the medium there is supposed to be as it were uniform, does indeed proceed straight; but at the point G itself, because that medium begins to grow rarer there, it is again refracted further from the perpendicular, along the same path toward the south, in proportion to the rarity of that medium, according to that axiom: rays falling from a denser medium into a rarer one are refracted away from the perpendicular. For the ray bursting out of the head of the comet falls into that rarer medium at an oblique angle.

Next, if that refracted ray A C D G has the force to carry itself further, it is in this way bent more and more, and refracted from the said perpendicular, and indeed at each of the points H I K L M N etc., because the medium continually decreases in density; and hence that ray proceeds, with a certain bending, in the direction in which it began to proceed at the start, by reason of its inclination. Since this line, then, proceeds refracted so many times, the tail must of necessity appear in a winding and curved form.

But know that this refraction and curving takes place not only at these many circles that we have drawn, but at innumerable successive points. For that rarer matter adhering to the comet does not always keep to such strict bounds as we have drawn for the sake of the demonstration, but increases or decreases little by little and gradually; and therefore the solar rays, too, are refracted and curved more and more, continually, without interruption and intermission.

[Margin: Refractio & incurvatio radiorum fit ſenſim, & ſucceſſivè, ſine interruptione,] *The refraction and curving of the rays takes place gradually and successively, without interruption.*

In the way in which the ray A C D is refracted, moreover, nearly all the others are refracted too, whichever pass through the head of the comet, so that they proceed nearly parallel; or, if some difference arises, these rays are drawn together at the extremity, so that they appear to converge, as it were, into a point, or to be widened and spread apart a little, according to the refraction and reflection that first arose in the head.

Let this, then, be said of the solar rays first reflected in the head of the comet. Now I shall also add something, though in a few words, about the rays that are only refracted in the rarer matter of the head, which, as they strike a more solid body, so also cannot be reflected and driven back [?]. But although these rays are not reflected by some harder body, they are nevertheless refracted toward that path in the same way, as we have shown for the others, the reflected ones.

[Margin: De radiis in materiâ rariori capitis refractis.] *On the rays refracted in the rarer matter of the head.*

For since all the rays of the Sun projected onto the head of the comet, whether they strike against some body or merely fall bare into the rarer matter mixed in among the bodies, are carried at a similar oblique angle, they are certainly refracted in the same way away from the perpendicular, according to the earlier course, as they fall into that transparent medium lying hidden behind the comet: although not each and every one of them proceeds at such equal distances from one another as we have shown for the sake of understanding; but most, as is easily understood, since that thinner matter of the head is not entirely of the same density and rarity, just as not all the surfaces of the bodies on which some fall have a similar inclination, and therefore also equally exact-

[Margin: Non omnes radii æqualiter, & ſub ſimilibus planè angulis inclinationis & reflexionis progrediuntur.] *Not all rays proceed equally, and at entirely similar angles of inclination and reflection.*

Diagram. A full-page engraved plate, numbered Fig. Q. at lower left and signed at the lower centre *Autor ſculpsit.* (Engraved by the author). It shows seven comets drawn one below another, numbered 6 to 12 above their heads. Each head is round and rayed, filled with horizontal hatching and stippled patches, and carries no letters; each hairy tail runs to the right. Comet 6: the tail rises and curves down toward its end. Comet 7: the tail rises to the right and fans out at its end. Comet 8: the tail runs to the right and curves upward at its end. Comet 9: the tail bends up, down and up again in an S-shape, labelled *Cauda flexuoſa* (winding tail). Comet 10: the tail bends down and then up, labelled *Cauda flexuoſa* (winding tail). Comet 11: the tail runs down to the right and turns up at its end, labelled *Cauda hyperb. ſive parabolica.* (hyperbolic or parabolic tail). Comet 12: the tail rises and then sweeps down to the right in a broad curve, labelled *Cauda Lenticularis.* (lenticular tail). Tails 6, 7 and 8 carry no label.

- Comet 6 (above the head): 6
- Comet 7 (above the head): 7
- Comet 8 (above the head): 8
- Comet 9 (above the head): 9
- Comet 9, right of the first bend of the tail: *Cauda flexuoſa* (winding tail)
- Comet 10 (above the head): 10
- Comet 10, right of the head: *Cauda flexuoſa* (winding tail)
- Comet 11 (above the head): 11
- Comet 11, above the tail: *Cauda hyperb. ſive parabolica.* (hyperbolic or parabolic tail)
- Comet 12 (above the head): 12
- Comet 12, below the tail: *Cauda Lenticularis.* (lenticular tail)
- Lower left: *Fig. Q.*
- Lower centre: *Autor ſculpsit.* (Engraved by the author) ly equidistant, cannot proceed. Therefore, although they all agree on this point, that they

deviate from the perpendicular toward the same course, nevertheless they do not all proceed equally, that is, at entirely similar angles of inclination, and also of reflection. And from this, too, a crossing [decuſſatio] of these rays occurs here and there, so that the tails by no means keep at all times so uniform a tenor as we have indeed drawn in figures 4 and 5, on the convex side as much as on the concave; but for the most part they appear hairy, like curved brooms or an ostrich feather: the appearance in which the greatest part of comets is observed.

It also follows from this, because of that very diverse refraction and reflection in the head (above all since the head changes and varies from hour to hour as to the position and shape of its bodies, and also the density and rarity of its matter), that hardly any comet is entirely similar to another in respect of its tail, and that one and the same comet cannot always, throughout its whole duration, show a similar and constant tail: at one time the greatest part of the rays, from that diverse reflection and refraction made in the head, flows together toward the convexity, at another toward the concavity; so that they are seen now on the upper side, now on the lower, more hairy and clothed with more hairs; and they also shine and appear with a more curved face on one side than on the other, as is plain from the appended images of certain comets, fashioned under the numbers 6, 7 and 8. Therefore, for these reasons, to say nothing of very many others, the tails of comets vary exceedingly, so that by no reckoning at all is any comet, even as to its tail, wholly equal and similar to another. Since the variation of the head, in respect both of its matter and of its corpuscles, as much in position and form as in density and rarity, and also that transparent medium by which the comet is surrounded, can be of infinite diversity, the solar rays are therefore reflected and refracted in a wonderful way, now thus, now otherwise.

[Margin: Quare tam diſſimiles, & adeò inconſtantes Cometæ referant caudas.] *Why comets show such dissimilar and such inconstant tails.*

So far we have examined tails curved downward toward the south; now, however, we shall consider those drawn upward toward the north, under diagram 5 of the preceding Fig. P. The account of these tails is entirely similar to that of the ones curved downward, provided, that is, that the transparent medium adhering to the comet likewise decreases in density: then they are covered by the same demonstration; except that in these tails bent upward the inclination of the rays arising from the reflection of the head tends in the contrary direction, upward toward the north, just as in the earlier tails it tends toward the south. And hence the rays, too, are gradually curved upward, from the perpendicular A D Y toward the north. For the curving, as we have said, always follows the course of the inclination, as will be clearly shown by certain examples.

[Margin: Quomodo ſursùm Septentrionem versùs Caudæ incurventur.] *How tails are curved upward toward the north.*

1. In the comet of the year 1577, about which Tycho noted the following in the preface to Book II *de Com.*: *Moreover, the tail itself was somewhat curved, so that it turned its convexity to the zenith and its concavity to the horizon*; that is, downward toward the south, as can be seen from the preceding Figure 4. In the same comet, throughout the whole time of its appearance, the inclination of the tail from the straight line of opposition to the Sun was southern, declining downward toward the horizon, as is clear from the little table of inclination inserted on page 488, and also from Book II, Chapter VII, page 162, of Tycho: *For by no means*, he says, *do I find its exten-*

[Margin: Incurvatio ductum inclinationis ſequitur] *The curving follows the course of the inclination.*

[Margin: Exemplis quibusdam probatur.] *It is proved by certain examples.*

[Margin: Cometâ 1577.] *The comet of 1577.*

sion to have proceeded exactly in a straight line with respect to the Sun, but to have inclined itself perceptibly from the arc of a great circle, drawn from the Sun through the head of the comet, toward the more southern part of the sky. And although that inclination was at one time a few degrees smaller, at another larger, it nevertheless remained constantly southern, toward the ecliptic.

2. The tail of the comet of the year 1618, the later and very great one, according to the notes of many observers, swelled with its curvature toward the north, and ran out with its concavity and point toward the south and the ecliptic. Above all, if we believe Cysat and his drawings attached to Chapter IV of his *Cometographia*, the tail was curved downward until December 7; from the seventh until December 16 it extended almost in a straight line; and from then until its last appearance it showed its curvature and concavity upward toward the north, but its convexity downward, as is understood more clearly from the author's own words, which it will not be out of place to add here.

[Margin: Cometâ 1618] *The comet of 1618.*

[Margin: Cometa 1618, per aliquot dies, crines in directum projecit.] *For several days the comet of 1618 threw its hair out in a straight line.*

For a notable observation rests on them, and our opinion, namely that the curving of the tail always tends toward the same part of the sky toward which the inclination from the line of opposition to the Sun is directed, is strengthened not a little by it. *On December 1* (he says) *the rays of the coma flowed out from the star not perpendicularly, nor in a straight course, but in an arc curved upward and downward (more upward)*; so that it faced the north with its convexity, but the south with its concavity, as can be read in several places there. *But on the 7th the tail of the comet* (he adds on page 64) *was no longer bent upward in so notable an arc* (with its convexity, that is) *as on the preceding days, but extended almost in a straight path.* On the 17th, in the morning, it was again curved, with a bend near the zenith, so that it directed the concavity and apex of the tail to

the north, toward parts entirely opposite to those of its first appearance, as is clearly evident from his accurately drawn diagrams.

Now therefore, in accordance with the curving, the inclination of the tail must necessarily have changed too, according to our opinion. But the matter seems to stand otherwise from Cysat's calculation; for from the seventh to December 20, as is clear from Chapter IV, prop. 11, *de Comet. anni 1618*, the inclination was, namely, constantly northern throughout the whole time of the appearance; whereas it ought to have been southern at the start, nearly none around the middle, and northern at the end.

[Margin: Cometa 1618 planè aliam inclinationem posſedit, quàm Cyſatus ei attribuit.] *The comet of 1618 had an entirely different inclination from the one Cysat attributes to it.*

[Margin: An Cometa, pro incurvationis ratione, inclinationem quoq; mutaverit?] *Whether the comet also changed its inclination in accordance with its curving?*

But in truth, from our computation, as can be seen from the table of inclinations of comets added on page 488, even though everything was investigated rightly and accurately from his very own directions of the tail, the declination of the train comes out far otherwise, and agrees wonderfully with our hypothesis. For since from December 1 to December 7 the inclination was markedly southern, 13 degrees more or less, the tail too, as the observations testify, therefore appeared curved toward the south and the horizon. But on December 7, because the inclination was only 1° 6′, on the 8th 0° 7′, and on December 9 1° 21′, the curving of the coma on those days was therefore no longer so great; rather, as we mentioned above, the tail at that time pointed almost to the part opposite the Sun. Again, from this time, from December 16 to January 7, after the inclination had become notably northern, the curvature of the tail was likewise turned upward toward the north, as the table of inclinations clearly shows. Kepler, moreover, seems to establish this very point more and more, concerning the same comet of the year 1618, in the *Physiolog.*, page 101.

[Margin: Keplerus ſententiæ Autoris adſtipulatur.] *Kepler agrees with the author's opinion.*

in whatever direction the tail declined from the point opposite the Sun, in that same direction the figure of the tail itself ran out with its extremity. If we had accurate observations of the curved tails of several comets at hand, we would have a mind to investigate this matter further; but since we are entirely without them, we shall have [observations] to attend to all the more carefully in future. Meanwhile, however, I do not doubt that nearly the same thing always happens with all comets shining with curved tails.

And this is indeed entirely how the matter stands, as we have just indicated, when the transparent medium by which the comet is surrounded is given as decreasing in density, beginning from the head. But when, conversely, it increases, that is, is thinner near the head and the further from the comet the denser it is, then the matter is indeed very different, and the curvature of the tail by no means follows the inclinations; but although the inclination, for example,

be given as southern, the curvature can nonetheless be northern. For even if the solar rays, as in diagram IV, Fig. P, are projected downward from D toward G, from a southern inclination, those rays would nevertheless not at once be refracted downward from the perpendicular, as indeed happened before at G, H, I, K, L, etc.; rather, immediately near H, they would reverse their course, namely toward the perpendicular, showing a curvature upward: that is, when that medium and the head were thinner, and somewhat denser around the extremity of the tail. Likewise, although the inclination were northern, given the same medium gradually somewhat denser, the tail, for the same reasons adduced, would by no means incline upward, as diagram V shows, but downward, and so the entire contrary would happen.

[Margin: Dato medio diaphano, quà denſitatem creſcente,curvatura neutiquam inclinationes caudæ imitatur.] *Given a transparent medium increasing in density, the curvature by no means imitates the inclinations of the tail.*

Therefore the tails of comets can be bent and curved in every direction without distinction, upward and downward, according to the constitution of the comet with respect to the Sun, the disposition of the head, and the nature of the transparent medium in which the rays are halted and made firm, as we have deduced at sufficient length.

[Margin: Poſſunt caudæ quaquaverſum incurvari.] *Tails can be curved in every direction.*

Further, to advance in this subject we have taken up, a question must first be untangled here: whether the curving of the tails is always similar and equal at all times, and how far it runs out when it is the greatest of all? To the first it is indeed not hard to reply: namely, that it can in no way happen that the curving is always the same, since the inclination of the rays from the point opposite the Sun, and also the reflection and refraction, are never alike; so it must vary considerably, according to the variation and change of those causes from which the curving is produced. The second question, however, is far deeper, because of the lack of observations: namely, how far the angle of curving sometimes grows, which is formed by the line drawn from the Sun through the head of the comet to the point opposite the Sun, and at the same time to the extremity of the curved tail. To get rightly to the bottom of this, someone might say, a Delian diver [Urinatore Delio] is needed. For there are no observations at all at hand from which it is possible to demonstrate it. Yet we can conjecture with probability that this angle, and the curving, is always greater than the inclination. For since the refraction of the rays in that rarer medium accompanying the comet is added to the inclination besides, the angle of curving must necessarily always be greater than the inclination and curving of the tails. Next, we have also shown by certain examples of comets that the inclination of the tail sometimes, to 20 and more, ex-

[Margin: An inflexio caudæ omni tempore æqualis,in Cometis appareat?] *Whether the bending of the tail appears equal at all times in comets?*

[Margin: Caudarum incurvatio quanta ſit omnium maxima.] *How great the greatest curving of tails is.*

[Margin: Curvatura caudarum ſemper inclinatione major eſt.] *The curvature of tails is always greater than the inclination.*

tends degrees; and from this it is gathered that the angle of curving sometimes widens to 30 degrees, more or less. But am I divining entirely rightly? Future observations will teach us.

Secondly, it also matters to know whether the greatest curving of the tails always occurs around the very middle of the tail, or rather in some other place, and always in the same one? Certainly not. For the greatest curvature can be found around the emergence, the point, as well as the middle of the tail, namely according to the diversity of the matter, as it is denser or thinner here or there. For when the matter decreases gradually in density or rarity, then the tail is curved very little at the beginning, but at the end: that is, if that medium suddenly becomes denser or rarer. Conversely, if that medium varies suddenly near the head as to rarity or density, and slowly around the extremity, then the tail is bent suddenly at the beginning, and only gradually around the end, in proportion, as we were just saying, to the diversity of that medium.

[Margin: An gibbus caudæ incurvatæ perp[[e/c]]tuò in medio conſiſtat?] *Whether the hump of a curved tail always stands in the middle?*

And so the most diverse curvings of tails are produced, which very rarely represent sections of a circle. For I am convinced that, not rarely, widely different and wonderful forms of sections arise from the wonderful and most diverse refraction of that transparent medium: now parabolic, now hyperbolic, now elliptical, and these indeed more often than spherical; and that sometimes, too, various irregular, mixed curves, winding and serpentine, are generated, which are subject to no definite lines: namely, when the more dilute matter surrounding the comet does not increase or decrease in density gradually, proportionally and continuously. Then the curvings can by no means approach any regularity, whether spherical or elliptical. Indeed, if that transparent medium is far different around the extremities from what it is around the middle, so that, beginning from the head of the comet, it always becomes more dilute, [and] in turn increases in density in the same proportion; or, conversely, if that matter is densest of all in the middle and more dilute at the extremities: then indeed a wonderful tail would be produced, winding, namely, like a serpentine line, such an image of a tail as we sketched in drawing 9 of the preceding Figure Q. For first, when the transparent medium becomes thinner from the head as far as the middle, and the inclination of the rays arising from the head is southern, as we drew under diagram IV in Figure P, the rays are broken away from the perpendicular, and so the curvature tends downward; but as soon as that transparent medium begins in turn to condense, the rays are refracted back toward the perpendicular, upward, that is, in the contrary direction; and so, in consequence, such a tail necessarily appears winding. But if at the same time the inclination of the rays were southern on one side of the head and northern

on the other, and the matter, besides, were wholly different, one part from the other, and diverse on the upper and the lower side, in that case, I believe, the tail would at the same time be curved in the contrary direction, as was found in the comet of the year 1569, which we drew in Figure H under number 21.

[Margin: Vtrum caudæ arcuatæ ſemper circuli alicuj⁹ ſectionem; an verò aliam aliquam referant?] *Whether arched tails always represent a section of some circle, or rather some other one?*

[Margin: Poſſe aliquando Caudas mirâ facie inſtar lineæ ſerpentinæ apparere.] *That tails can sometimes appear with a wonderful face, like a serpentine line.*

For these reasons, then, tails sometimes shine forth that consist of mixed lines, curved and straight, or winding and straight, and at times also of shell-shaped [conchalibus] and lenticular lines and other entirely irregular lines; various lines of this kind Alb. Dürerus [Albrecht Dürer] teaches how to describe in his work: lines which partly at the beginning al-

[Margin: Caudæ admirabiles & irregulares.] *Wonderful and irregular tails.*

most are straight, but around the exit are curved in diverse ways: now according to spherical, now according to conic sections. When, however, tails are to be composed of straight and curved lines, it is necessary that in some definite place the matter be somewhat more dilute, uniform over some notable stretch, and drawn out in length. There, then, along that course and with that uniform consistency of the matter, the rays appear only straight, until in turn some denser or rarer medium enters; and then those rays are bent either upward or downward. Moreover, if such a variation occurs rather often in the same tail, different straight stretches are seen here and there, under the head itself, in the middle, as well as at the extremity. Therefore, to sum the matter up in a few words, the curvature of the tail is produced by reason of the transparent medium and of the reflection and refraction of the rays. This curvature can be almost infinite, since the variation is almost impossible to determine: not only because straight lines are sometimes longer and shorter, but also because curved ones are frequent, circular, shell-shaped, elliptical, parabolic and hyperbolic, as is easily understood. But however credible it may be that this can happen to tails in just this way, faces of this kind are nevertheless hardly ever made out. For the collateral lines, which are not thrown through the centre of the head but toward the sides, and which stretch out obliquely across, through the remaining rays, mostly spoil the genuine figure of the tail; so much so that [the tails] seem simply winding, consisting, that is, of curved lines, and the straight ones are, as it were, wholly absorbed and extinguished by those transverse rays meeting crosswise here and there. But when that transparent medium increases or decreases only once, yet in such diverse ways that in some definite place (for example, around the middle of the transparent body) the rarity or density of that medium increases or decreases suddenly, and around the extremities very slowly: on these suppositions the tail takes on a parabolic or hyperbolic figure, or another of this kind, according to the constitution of

the medium. Kinds of tails of this sort, which nature does not entirely abhor (although they come into view very rarely), and such as I firmly believe have also, without doubt, sometimes appeared, if only our predecessors had left them to us accurately recorded, we have shown under numbers 6, 7, 8, 9, 10, 11 and 12 of the preceding Figure Q.

[Margin: Caudæ inflectuntur ratione medii diaphani,& radiorum reflexionis & refractionis.] *Tails are bent by reason of the transparent medium, and of the reflection and refraction of the rays.*

Thirdly, it is now also asked whether every comet endowed with a definite figure, and above all with a curvature, shows the same face and curvature constantly through its whole duration. By no means; for manifold reasons, partly already stated here and there in this work of ours, partly still to be brought forward. 1. That the figure of the head changes greatly from day to day, as much in respect of the matter, now more dilute and now denser, as of the increase and decrease of the nuclei and opaque bodies, which are now joined, now separated, and change as to their figure, according as the rays of the Sun are successively reflected, refracted and inclined in diverse ways in the very head of the comet. 2. That the rarer medium clinging to the comet through the whole time of its appearance does not remain the same perpetually, but rather changes from day to day, indeed from hour to hour. For that matter continually undergoes a notable alteration: while some of it is dissipated, other, fresh matter is substituted in its place, now rarer, now thinner, in this or that place of the tail, now under the head, under the middle, now around the point; so that those degrees of density and rarity, to most di-

[Margin: An Cometa eandem conſtanter incurvationem caudæ,quàm initiò offert,retineat?] *Whether a comet constantly keeps the same curving of the tail that it shows at the beginning?*

verse vicissitudes, are incessantly subjected. This is what happens with the faculae and shadows of the solar spots, as our *Heliographia* testifies, and also the *Rosa Ursina* of Scheiner, in which, on pp. 156 and 344, the same is affirmed: namely, that they are always engaged in perpetual change. *Some* (he says) *persist for several days* (the shadows, that is, and the faculae); *some for fewer; some for scarcely one; some do not exceed a stay of an hour, as I found in many while observing.* In no different way it can also happen that the matter lying hidden behind the comet is now rarer, now denser; especially since such sudden changes easily arise from the motion of the comet, so swift as it is, to say nothing of all those variations and alterations of the tails that take their origin from the varied position of the comet with respect to the Sun and from its various aspects, of which we shall have to speak more fully shortly. It is therefore no wonder that tails vary so wonderfully and undergo such wonderful changes and vicissitudes, when, that is, these causes concur. And there is certainly no reason for you to doubt that such remarkable changes in the tails of comets have also, at times, actually occurred. For, on the authority of Pliny, Book II, Chapter 25, in Olympiad 108 *the image of a trumpet was changed into a spear*; again, on the

testimony of Cornelius Gemma, on 1577 November 28 the comet acquired a double tail; and indeed on the 3rd it threw out three other rays from the head into different regions of the world. Moreover, just as straight tails spring forth from arched ones, and curved tails from straight ones, as you have learned in its place (indeed, not rarely the same tail is bent in the contrary direction within a short time, as was observed in the year 1618), so too from arched tails, circular, lenticular and conic, winding ones arise; and conversely, from winding ones, simply curved ones, and also entirely straight ones. As for the fact that more comets more frequently [appear] with tails stretched out straight, or, if they show arched tails, that these swell in one place only, the reason is this: that the transparent medium surrounding the comet is mostly of one and the same rarity and density, and hence the train, too, appears almost straight. Or else, if the medium has different degrees, increasing or decreasing only gradually in some definite proportion, then the tails are seen with only a single, simple curvature.

[Margin: Maculæ,faculæ atq́; umbræ continuis mutationibus ſunt obnoxiæ.] *Spots, faculae and shadows are subject to continual changes.*

[Margin: Facies caudarum mirificè variari, exemplis probatur.] *That the face of tails varies wonderfully is proved by examples.*

[Margin: Cometa diverſiſſimos radios in diverſas Cœli partes ejaculatus eſt.] *A comet shot out most diverse rays into different parts of the sky.*

[Margin: Cur caudæ ſæpiùs rectæ; vel ſi arcuatæ, uno loco tantùm intumeſcere videantur?] *Why tails seem more often straight; or, if arched, to swell in one place only?*

With these matters now completed, it will be easy for us to unravel other questions of no trifling worth, which have tormented the philosophers exceedingly and which most have passed over entirely in silence. First, from what cause tails twinkle, flash, or quiver, or wave; second, from what cause tails shine on one day, indeed in one hour, longer and more splendid, in another, again, shorter and weaker, and now once more with their former face; and why they are seen at one time to perish entirely, even in a very clear sky, and at another to emerge again unexpectedly? It cannot be denied that the first phenomenon certainly occurs at times in some comets: namely, in those endowed with a livelier light and possessing more splendid tails. Their tails, I say, twinkle and flash, and at times spit out, as it were, fresh rays, so that the tails seem to some extent to wave this way and that. This waving is sometimes so sudden that the tail appears now shorter, now, in the blink of an eye, longer through an alternating shooting-out of rays, and now flashes with a sudden quivering like chasmata. This can be demonstrated, from various comets accurately observed, not

[Margin: Quare caudæ nonnullæ ſcintillent, ac fluctuent; itemq́; per intervalla comprimantur, rursùs dilatentur.] *Why some tails twinkle and wave; and likewise why at intervals they are compressed and dilated again.*

with difficulty. 1. By the comet of the year 1556, about which Cardanus reported: *At the beginning of March a comet, almost equal to half the Moon, with hair neither long nor constant, but glowing red as in a conflagration, as with torches when the wind blows on them; it was dark, red and turbid.* 2. In the comet of the year 1577, Kepler, in the *Physiol. Com.*, p. 102, thinks that almost the same was detected; and Cornelius Gemma also supports him in this: namely, that the comet did not have on all days a tail equal in length or similar in colour, but that at intervals it showed one longer, paler, more splendid and ruddier. Above all, concerning the comet seen in the year 1607, Kepler adds, at the same place cited: *For all who carefully contemplated the comet of the year 1607 will testify that its tail appeared now short, then, in the blink of an eye, long.* Likewise, p. 117: *the tail now short and suddenly quite long, to 8 and 10 degrees, flashing like the rods of chasmata.* Johann Baptist Cysat studied this phenomenon so carefully in the comet of the year 1618 that his observations deserve to be set down here; for much light will flow from them into this discussion of ours.

[Margin: Cometæ inconſtantibus caudis inſtar chasmatum.] *Comets with inconstant tails, like chasmata.*

On December 4 the head of the comet twinkled seldom and faintly; and at the same time as that twinkling occurred, the whole coma of the comet also waved, as if gently stirred by the wind. The rays of the coma, too, were as it were shaken out from the head, and were suddenly drawn back. This waving or reciprocation of the rays of the comet's tail was like that which usually occurs in nocturnal chasmata or celestial rods thrown out from a white cloud, or also like the radiation of Venus; for its rays too do not so much twinkle as leap, or vibrate to and fro. Moreover, this shooting-out of rays from the head of the comet happened in such a way that at length the coma, otherwise sharper at its extremity, was greatly widened and was scattered like a broom. And this phenomenon was noticed almost whenever it was possible to watch the comet; yet it was not equally notable on every day.

[Margin: Cometa caudâ fluctuante, & reciprocante mirabili.] *A comet with a wonderfully waving and reciprocating tail.*

On December 7 the coma waved, with a sudden shooting-out, a widening, and an alternating constriction.

On December 8 the coma waved frequently, widened, contracted, etc. This waving and vibration occurred on December 24 much more frequently still than at other times.

This is likewise attested by Kepler in his *Physiolog.* [?], p. 103, and on p. 58 of *de Com.*: *The tail sometimes flashed, so that it was sometimes long, sometimes short; it was scattered from the head like straight and stiff brooms.* Wendelen, in *Teratolog. Com.*, p. 20: *The colour of this tail,* he says, *next to its head was fiery and ruddy, and from time to time, with certain flashes, as it were, and sparks, it imitated the slackening and intensifying of an alternating fire, as those rods usually do which we sometimes see quivering at night.* Likewise Snellius, Chapter VII, on the comet of the year 1618: *When I first,* he says, *observed it on November 30, this phenomenon presented an unusual spectacle to us. For at first, not far from the head, I could see*

the star in the right foot of Virgo quite freely through its coma; a little later a sudden brilliance of the rays and a density withdrew it [?] *from our sight, for it shone ruddier, with more frequent shreds of hair, as if new matter and flame were boiling up more densely; and in turn, not so long after, it gave us back the sight of the same star: you would have said plainly that the coma burned with a denser flame. And when at first I put this down to the air and to clouds running beneath, and nevertheless the stars near the comet, even*

[Margin: Kepleri teſtimonium[[./,]]] *Kepler's testimony.*

[Margin: Wendelini.] *Wendelen's.*

[Margin: Snellii.] *Snellius's.*

[Margin: Num iſta ſubſultatio & vibratio caudæ, aëri vel nebulis adſcribendum ſit ?] *Whether this leaping and vibration of the tail is to be ascribed to the air or to clouds?*

the smallest, I saw exactly as before, I perceived that there was no ground at all for referring the cause of this variation to the region of the air near us.

We too noticed something not unlike this in the comet of the year 1652: not, indeed, such intense and lively flashings and twinklings of the tail, or vibrations of the rays, but that the coma appeared now shorter, now longer. In fact, if we weigh the matter accurately, it ought by rights to have been shortened and diminished from the very beginning to the end, because of the comet's continual departure from the Earth. Nevertheless, it sometimes appeared longer on the following day than on the preceding one. This can indeed be excused to some extent, if it is put down to the air, now purer, now murkier, and to the lower positions of the comet, and to the vapours that always hang about the horizon. Accordingly, I also [?] do not much oppose [the view] that such sudden vicissitudes sometimes arise from these causes, so that at first I could scarcely be persuaded that other causes lay hidden here. But when I perceived that not only here in Danzig was the tail of different length at different times, and longer above all on the later days, but that the same had also been detected elsewhere, by various observers in far distant and more remote regions, I saw very well that this could in no way be ascribed to a thicker air and to vapours. For on December 26, with a very clear sky, the coma was only two degrees; but on the 27th, both here in Danzig and at Cologne [Coloniæ Agrippinæ] and Greifswald [Gryfswaldiæ], as we noted on p. 458, it appeared four degrees long. Again, on the 30th it was seen so short that on the following days, namely the 31st and January 1, it could scarcely be made out any longer; and yet on January 3 it not only came clearly into view but also showed a length of two degrees, more or less.

[Margin: Simile quid in Cometis 1652 & 1661 ab Autore deprehenſum eſt.] *Something similar was detected by the author in the comets of 1652 and 1661.*

[Margin: Fæculentior aër,decliviorq́; Cometarum ſitus, poteſt tale phænomenum nonnunquam inducere.] *A murkier air, and a lower position of the comets, can sometimes produce such a phenomenon.*

Finally, I detected a similar phenomenon on February 6 in the tail of the comet which appeared a few days before, namely on 1661 February 3, and which is still shining in the aether as I write. For in a quite clear sky the tail flashed from time to time with a vibration, as if continually pouring out fresh rays, so that it seemed in a certain way to waver.

[Margin: Cometa anni 1661 Caudam ſimilem vibrantem & micantem exhibuit.] *The comet of the year 1661 showed a similar tail, vibrating and flashing.*

From these examples one may learn that these comets, too, showed changeable shootings-out of rays of this kind, and diverse vibrations; although not so notable and sudden as that of the year 1618. For the comet of the year 1652 showed only such as [occurred] on one day or another; but this one, such as were noticed almost all the time; although in this most recent comet the vibration and the shooting-out of the rays were also fairly sudden. Since, then, it is most certain that in the tails of some comets (as is clear from the examples just adduced) inconstant flashings appear, so that the rays seem now shorter, now longer, now narrower, now more spread apart around the extremity, and as it were shoot out new rays from time to time, then flash, and spew out lively vibrations, the question is: what is the true and genuine reason for this phenomenon? But I would like you first to notice here that this flashing of the tails, or vibration of the rays, never inclines to the sides, but mostly straight out from the Sun and toward its opposite. The most sagacious Kepler also duly noted this in the comet of the year 1618: *The tails of comets do not glow red* (he says, *Physiol.*, p. 103) *like flames agi-*

[Margin: Quænam vibrationis, & fluctuationis caudarum vera ſit ratio ?] *What is the true reason for the vibration and waving of tails?*

[Margin: Vibratio caudæ pleruną; in directum procedit.] *The vibration of the tail mostly proceeds in a straight line.*

tated, flashing to the sides; but they flash straight on, constantly toward the same quarter, namely the one turned away from the Sun.

[Margin: Quâ ratione Peripatetici hocce phænomenum ſalvare ſtudeant.] *How the Peripatetics try to account for this phenomenon.*

On this very question, however, if the Peripatetic philosophers are to be heard: since they hold firmly that the bodies of comets are kindled and blazing terrestrial vapours, they will hence affirm, constantly and boldly, that the coma is nothing but flame. For just as a flame never, or only very rarely, rises evenly upward, but fitfully, or in broken spurts, and unevenly, and moreover always acquires, as it were, fresh strength or flames, and belches out rays turning in perpetual agitation; in the same way, they say, the flashings, vibrations and shootings-out of rays occur in the tails. But however plausible this argument may seem to someone at first sight, it nevertheless collapses entirely with almost no effort.

[Margin: Vno ictu totum corruit argumentum.] *At one stroke the whole argument collapses.*

For here and there in this work we have quite abundantly destroyed the foundations of this Peripatetic doctrine on the origin and passing away of comets: namely, that they are not terrestrial vapours or exhalations burning in our air, but wholly celestial bodies, compacted of ethereal matter and lit by the Sun. Therefore the radiance, too, can by no means be like a flame, much less can inconstant vibrations and flashings of that kind arise from it. Indeed, supposing, but not granting, that the tails are flames, then certainly (as Kepler rightly says) they ought always to advance, in the manner of flames, along a winding and serpentine course. Since, however, the case is entirely otherwise, we by no means take the coma for a flame — to say nothing of the remaining reasons that could be brought forward against that opinion, if we had to dwell here any longer.

[Margin: Nec Keplerus nec Snellius metam omninò attingunt.] *Neither Kepler nor Snellius fully reaches the mark.*

Others, however, who aim somewhat closer to the mark and likewise place comets in the aether, such as Kepler, Snellius and others, assert that those flashings arise because the solar rays, passing through the head of the comet, continually carry some fresh matter along with them into the quarter opposite the Sun; on which account that matter, clinging to the head and receiving the Sun's rays, is ceaselessly changed and varied. And therefore, since the matter is in perpetual motion, the twinklings and vibrations of the tail are produced. But not even this reason, though it is not wholly groundless, is fully adequate to the matter. For indeed, as we have shown on p. 476, the tail is by no means an outflow drawn from the head, as Kepler holds, and that matter in which the solar [?] rays come to rest does not flow out of the head of itself, but comes from somewhere else entirely; therefore that matter flowing out of the head in no way produces that phenomenon. I do indeed admit that the continual motion of that matter contributes something to this business, if other causes come in addition; but this agitation of the thinner matter does not flow from where Kepler wants it to, namely from the head itself, nor is it drawn out by means of the solar rays; rather, as we were just saying, it is supplied from another store altogether.

[Margin: Autoris ſententia de hocce phænomeno.] *The author's opinion on this phenomenon.*

The genuine reason, however, so far at least as it seems to me, is this. Since the head of the comet consists of the most diverse matter, more dilute and denser, and also of larger and smaller, more solid nuclei, which from time to time change their shape, number and position and are in perpetual anomalous motion relative to one another, it certainly cannot happen otherwise than that both the solar rays, struck through the thinner matter of the head with refraction, and the rays from the sur- faces of the opaque bodies in the head, which are as it were perpetually fluctuating, being reflected, necessarily change constantly and from moment to moment. And from this it follows that the tail, or the Sun's rays passing through the head, are in continual agitation and fluctuation,

so that they appear now longer or shorter, now livelier or more languid, now to vanish entirely, then to burst out anew, with stray rays frequently mixed in; from which nothing can arise but a drawing-back and extension of the rays, or a widening and a contraction in turn.

[Margin: Pro motu corporum atq; materiâ capitis; nec non diverſitate atmoſphær æ Cometicæ,vibrationes, & micationes caudarum excitantur.] *According to the motion of the bodies and the matter of the head, and also the diversity of the comet's atmosphere, the vibrations and flashings of the tails are stirred up.*

Moreover, the matter surrounding the comet does not always remain the same either, or does so only very rarely. For, as you have learned, since in the comet's advance and passage different matter clings to the head at different times, one portion, namely, being dispersed and rarefied while another comes in its place, it follows that this matter is in a perpetual motion of condensation and rarefaction, and is also moved with a local motion in accordance with the proper motion of the head or body of the comet. For this reason, too, those solar rays, falling on that matter, ceaselessly present one aspect after another. Finally, just as the matter is made finer here or there, so at the same time the rays must, here or there, appear paler and thinner, indeed sometimes vanish almost entirely; conversely, the more the matter is condensed in places, the stronger and livelier the rays appear. Accordingly, in keeping with the motion of the bodies and the matter of the head, and also with the motion of the more dilute matter clinging to the head, the twinkling and flashing of the coma are produced, and the vibrations and dartings are intensified. Moreover, the more agitated this motion of rarefaction and condensation of the transparent medium is, the more sudden this appearance, or this phenomenon, is too; and conversely, the slacker that motion, the less perceptible that appearance is.

[Margin: In quibusnam Cometis vibratio, fluctuatio, & ſubſultatio radiorum ſit notabilior ?] *In which comets is the vibration, fluctuation and leaping of the rays more notable?*

For the rest, I am wholly of the opinion that this phenomenon occurs more frequently in the brighter, ruddy and fiery comets than in those paler ones that go about with a gloomy colour and light. And this indeed for the reason that their heads consist of more solid and more numerous nuclei, from whose surfaces the solar rays are reflected more strongly and with greater force, so that they appear livelier and more splendid. In these, then, when some alteration or diversity occurs, it is certainly recognized far more distinctly and clearly than in those comets whose rays are thin, weak and pale. For even if an entirely similar change of the rays befalls them, it is still not detected and seen so immediately or so clearly. Finally, the swifter the motion of the nuclei [and] of the rarer matter set between them in the head, and the motion of rarefaction and condensation of the matter surrounding the head, as we were saying a little earlier, the more sudden this phenomenon appears: that is, the more swiftly that flashing and twinkling of the tail is intensified, and the more frequent, too, are the fluctuation and vibration, so much so that the tail is sometimes seen to change

in the twinkling of an eye. And it should be no wonder that, from that sudden change both of the head and of its atmosphere, the tails sometimes become now narrower, now broader around their extremities or around the middle, just as if a kind of leaping occurred in the tails, or as if they were raised and lowered, as Cysat observed very diligently, especially on 1618 December 24.

[Margin: Quousq́; Caudarum dilatatio extendatur.] *How far the dilatation of tails extends.*

This dilatation of the tail, moreover, can, for the reasons brought forward, not only extend and widen itself to a whole degree and more, but the tails can also, as a result, be lengthened and drawn out from the head by several degrees more than usual — when, namely, those extraordinary vibrations and fluctuations come on in addition. This is evident from the observations of J. Bapt. Cysat made on December 8, 24 and 28: *The bulge* (he says, of the tail) *of the breadth, or the greatest breadth, was ordinarily 3 degrees; in the dilatation, 4 degrees.* He adds that its length also varied remarkably, as observations 24 and 28 clearly show. And that this arose only from that fluctuation and vibration [appears from the fact] that the tail, which was otherwise seen pointed and sharpened toward its end, sometimes appeared 4 degrees wide at intervals. Sometimes it fluctuated and leapt with a reciprocating vibration; sometimes it was sharpened at its extremity; sometimes it widened into the shape of a broom.

[Margin: Fluctuatio caudæ Cometæ 1618.] *The fluctuation of the tail of the comet of 1618.*

But to make the matter plainer, I shall set before your eyes in the following diagram how far the fluctuation and flashing of the tail around its point, in the comet of 1618, extended itself. In this diagram, and in the Figure above, we have first drawn with lines the ordinary shape and appearance of the tail; then with those dots we have sought to indicate the space, namely how far the dilatation and contraction, or the fluctuation and leaping, extended. It is therefore easily gathered that it is by no means absurd that a similar phenomenon may sometimes occur in other comets equally.

[Margin: Et aër noſter vaporoſus ad hocce phænomenum aliquid conferre videtur.] *Our vaporous air, too, seems to contribute something to this phenomenon.*

Our vaporous air, moreover, may also contribute something toward producing this phenomenon all the more: namely when more dilute little clouds and very thin terrestrial exhalations, which for the most part deceive the sight, fly about and run to and fro in the air, and indeed in such a way that they sometimes fly past the comet, cover it, or overshadow it. Hence that fluctuation is made far more noticeable and more inconstant than in wholly pure and clarified air. This very thing occurs rather often in observations of the stars. For at one time you will see the stars very splendid; at another, again, much duller in light and paler, although almost no change that anyone could detect befalls the air. If, therefore, I say, this change of the air just described were added to that violent alteration of the materials lingering behind the comet, so that those expirations surrounding the comet were suddenly attenuated and,

in turn, unexpectedly condensed, then it could certainly happen that the tail would sometimes vanish entirely and be extinguished, and burst out again, according to the diversity and constitution of the matter clinging to the head.

[Margin: Quando Cometæ caudis monſtroſis & abruptis ſe ſe oſtendant.] *When comets show themselves with monstrous and broken-off tails.*

And for these reasons no one ought to be surprised that the tails of comets appear with an altogether monstrous face, just as if they were broken off and scattered: if, namely, that matter we have mentioned, poured around the comet, were so interrupted and dispersed that here and there, as it were, fissures and passages were left — namely certain spaces wholly free of such thinner evaporations, and cleared — in which the solar rays, struck through the head, would by no means be fixed or come to rest; then, I say, the tail would appear interrupted and cut off, as if it alternately and by turns perished entirely and leapt forth again; and indeed in diverse ways, according to the matter supplied and the refraction and reflection of the solar rays.

We have drawn tails and comets of this kind in figure K above, p. 448, under numbers 37 and 38.

[Margin: Summa ſententiæ Autoris.] *Summary of the author's opinion.*

In sum, so that you grasp the matter correctly: according as the matter surrounding the comet is permanent or changeable, continuous or divided, longer or shorter, [and as] the head of the comet consists of more or fewer, larger or smaller nuclei and of matter intermixed with them; and in turn according as these nuclei are endowed with varied form and shape, and the solar rays passing through the head are then livelier or longer — so some comets present longer tails, others shorter; some continuous, others interrupted and divided; some, likewise, constant, others changeable.

[Margin: De multiplici caudarum lumine & colore.] *On the manifold light and colour of tails.*

Before we go further, however, I think we must also discuss the diverse and manifold light and colour of tails. For no comet is found entirely similar to another in this respect as regards colour, as it is not difficult to prove by almost innumerable examples, especially from our History of Comets. At times they appear luminous, shining and very bright, like gold; at times fiery, ruddy, reddish; at times somewhat dark, weak, pale, wearing a certain gloomy livid hue; at times they display a dark redness, a blackish, blood-red or reddish-brown colour, indeed an ashen one. Where so varied an appearance of the tails comes from, however, is now worth investigating.

[Margin: Color caudarum utplurimùm capitis colorem æmuatur.] *The colour of tails for the most part imitates the colour of the head.*

As far as one may grasp it, however (to put it briefly), the colour of a comet's tail mostly imitates the colour of the head; yet in such a way that the tail almost never enjoys the same brightness and splendour as the head, but more often shows a gloomier, paler and less conspicuous colour. It is certain that this comes about because we see the heads of comets — which, like the Moon and the

other planets, draw their light from the Sun — by reflected and reverberated rays, namely, and so under fairly acute angles; conversely, we perceive the tails of comets only through rays at once refracted and reflected, and then under a far more obtuse angle; and this refraction necessarily brings with it a certain weakness and obscurity. Add to this that the tails are seen in a certain rarer medium surrounding the head, and only by a double reflection do they first fall under our sight.

[Margin: Cur caudæ capitibus Cometarum pleruną; obſcuriores & debiliores ſint ?] *Why are tails mostly darker and weaker than the heads of comets?*

Hence I hold that, by a certain fixed law, the tails are seen altogether darker, thinner and weaker than the heads of comets, both in light and in colour, as those who are versed even slightly in optics readily understand. For, first, it is most true, beyond any contradiction, that refraction dulls and weakens the light of the Sun. Second, it is also plain that the light of the Sun reflected to us from the comet's Head — that, namely, which carries the image of the comet's Head to the eyes — is thrown to us under a much more acute angle of reflection, as if reflected from the front, than that light of the Sun which passes through the gaps and pores (if one may speak so) of the comet's Head and is reflected only from the surfaces of the sides of the corpuscles and nuclei making up the head; and then — which is the heart of the matter — it is first made visible to us only by means of a further refraction besides, on account of that flowing transparent [medium] surrounding the head of the comet.

That the heads of comets, moreover, shine with diverse colours is abundantly clear from Book VI above; and there we have clearly shown where they spring from and how they take their beginnings.

[Margin: Radii Solares quâ ratione coloribus tingantur.] *How the Sun's rays are tinged with colours.*

[Margin: Cometæ ſemper rubicundi[?]res in crepuſculo apparent.] *Comets always appear redder [?] in twilight.*

I say, therefore, that just as the colour of the head comes about, and varies in diverse ways, according to the variety of the matter it consists of, according to the varying degree of its density and compaction, and according to the variation in the rarity and density of that same matter, whether through the accession of new matter or the departure of old, so too the tail of the comet first takes on various colours, then also retains them, and changes them into others. The reason is evident: just as the Sun's rays passing through coloured glass are tinged according to the various colours set into the glass, so in the same way those solar rays, descending through the matter of the head of comets, are imbued with the very colour with which that matter is then endowed; with only this difference, that they always have a somewhat duller light, or colour, and one not as vivid as the head itself. Yet these appearances vary a great deal according to the varying situation and the elevation of the tails above the horizon, and I would like you to note this well. For in a lower situation, when comets first rise or set, with the tail standing in the twilight, whether

morning or evening, where the twilight matter mostly shines with a yellow colour from the Sun's rays, [the tail] always appears redder than in any other situation outside the twilight, entirely free from all horizontal refraction. The reason, again, is ready to hand: the rays of the tail passing through the twilight matter are coloured in the same way as the Sun's rays driven through coloured glass.

[Margin: Vnde caudæ clareſcant; & rursùs hebetentur ?] *From what cause do tails grow bright, and grow dull again?*

Now the clarity and brightness of tails, or their splendour, takes its origin from two principal causes. First, when the head is formed of more compact and more solid nuclei, the tail reflects stronger and more vivid rays than if the head consisted of rarer and thinner matter; just as a ball struck against a wall, or against some other more solid matter, rebounds more strongly at a certain angle of incidence than if it falls on softer matter, such as wool, or any other that resists less. For that rarer and thinner matter weakens, dulls, blunts, indeed confounds all reflection: hence the light projected from it is always weaker, more leaden, and less conspicuous. Next, the clarity and splendour of tails is also intensified, and as it were kindled more and more, when the head of the comet is composed of very many more solid nuclei and corpuscles, and of various surfaces inclined in diverse ways. For these surfaces not only reflect infinite rays, and indeed not rays scattered here and there to the sides, but very many that intersect one another in various ways, so that some receive others crosswise and, as it were, cast themselves together into one heap: for this reason tails grow bright, especially if the transparent body surrounding the comet possesses notable density. But where the heads consist of fewer and thinner nuclei, there they also return reflected rays that are less frequent, and moreover mostly scattered and thinner: hence the tails seem to shine less and to be duller, above all if the transparent body just mentioned is rarer and thinner.

[Margin: Cur caudæ circa caput atq; eductionem lucidiores & vegetiores ſint ?] *Why are tails brighter and more vigorous around the head and their outlet?*

It also follows from this that, as a rule, the nearer the parts of tails are to the head, the more vigorous and splendid they are than the remaining part, which lies farther off. Since there far more rays intersect one another and gather together, whereas around the tip the rays are mostly dissipated and attenuated, and a great many to the very extre- [Margin: Nonnullæ caudæ circa extremitatem ſunt ſplendidiores reliquâ parte.] *Some tails are more splendid around their extremity than in the remaining part.*

mity, because of the various inclinations of the bodies and the refraction of the matter, do not reach, but vanish here and there along the way and are cast out one by one to the sides, the tail grows dull and rarefied there. For all rays grow dull as they advance, and are gradually consumed. Sometimes, however, it can happen that some tails (though, I think, very rarely) are seen brighter and more splendid around their outermost parts, those farther from the head, than in the vicinity of the head. That is, when the greatest part of the rays

first converges around the outermost parts, or the tip, and when, perhaps, that transparent body which surrounds the comet and receives the tail is also denser there than in the remaining part, so that in that region it reflects and refracts the rays more perfectly and more copiously: then it is not absurd that tails may be found brighter and denser around their extremities and tips than at their outlet around the head itself.

[Margin: An caudæ quorundam Cometarum æq; fulgidæ & claræ, ac ipſa capita dari poſſint ?] *Whether the tails of some comets can be as gleaming and bright as the heads themselves?*

[Margin: Cauda Cometæ 1607 ferè ejusdem coloris & luminis cum ipſo capite extitit.] *The tail of the comet of 1607 was of almost the same colour and light as the head itself.*

Indeed, if we weigh the matter more deeply, there can be such a constitution of the head and of the medium adhering to it that the tails, from their very outlet all the way to the tip, and even together with the heads themselves, are of entirely the same colour and clarity, and proceed with an even tenor on every side: like the comet of Nicephorus, which appeared in the year of Christ 409, according to Calvisius, at the time of an eclipse of the Sun; and also the comet of the year 1607, about whose tail Severinus Longomontanus states the following: *The tail of the comet was dense, and perhaps more so than the others, and of the same colour as the head itself, namely leaden and somewhat Saturnine* (*Book on the New Phenomena of the Heavens*, Chapter IX). In a phenomenon of this kind, however, that consistency behind the comet must be of nearly the same density and rarity as the head itself. But just as it happens very rarely that matter so immense and so exceedingly thick, and at the same time transparent, can exist, so for that reason such kinds of comets are very seldom seen.

[Margin: An caudæ Stellas omnino eclipſare poſſint ?] *Whether tails can eclipse stars completely?*

[Margin: Cometa 1618 nonnullas fixas obſcuravit, imò penitùs texit.] *The comet of 1618 obscured some fixed stars, indeed covered them completely.*

Through tails of this kind, even though [they] are carried beneath a particular star with respect to us, the fixed stars are seen only with difficulty; rather, they are wholly hidden and eclipsed by the tails, as usually happens with the heads, because of the density of the matter. On the other hand, a good many tails, as we noted earlier, are so much more diluted and more translucent than the heads of the comets themselves that they often by no means deny passage even to the rays of the smallest fixed stars; and very many appearances of such tails have occurred: in some, a little star flashed out here and there; at other times one was completely covered. This phenomenon was not infrequent in the case of the comet of the year 1618, as Cysat (Chapter IV) and Crüger (Chapter I) testify. Namely, on December 1, Arcturus itself; on the 8th, the unformed [star] below the tail of Ursa Major; on December 15, the lower of the following [stars] in the square of Ursa Major, which I call the one in the Hip; on the 20th, the last [star] of the Tail of the same Bear; some were also completely overshadowed

by the head itself on December 7, as the same Cysat reports on p. 64. *The stars* (for, he says) *shining through the rays of the coma near the head today and on the following days (for we observed several shining through in this way) were somewhat obscured by the comet's rays, a cloud, as it were, being drawn over them, and so they suffered a kind of eclipse.*

[Margin: Caudæ nonnullæ adeò ſunt tralucentes, ut Stellarũ adſpectum nobis minimè denegent.] *Some tails are so translucent that they by no means deny us the sight of the stars.*

The same happened in the comet of the year 1652, on December 20. For a certain little star above the foot of Orion, in Eridanus, flashed out very clearly, namely in the middle of the tail. Likewise in the comet of 1661, on February 10. Something similar, too, Ty- cho detected in the comet of the year 1577, as one may read in the letter to Rothmann dated 1589 February 21: *We too saw* (he writes) *in the hairy star of the year 77, whose tail was very notable, especially at the beginning, that the tail was very rare and appeared like thin rays, so much so that certain stars which it passed by shone through it at times. Nor was it of the same colour as the head; it also changed its colour from time to time. The head itself was solidly compacted and much brighter than the tail, and was seen to be exactly round.* From this, certainly, it is clear that such phenomena are very frequent. Since comets are always carried beneath the fixed stars, in the region of the planets, and their tails are mostly more diluted than the heads.

[Margin: Caudæ nonnunquam habent nucleum, ſeu medullam.] *Tails sometimes have a nucleus, or pith.*

Yet that matter of the tails, as is plain from what has gone before, does not observe or retain equal degrees of density or rarity on every side, nor in all tails; rather, the denser parts shine out now on this side of the tail, now on that, now in the middle, now at the extremity. The Fathers of the Society of Jesus at Rome noticed a notable example of this in the comet of the year 1618: namely, that its tail showed, in its very centre, a nucleus as it were, or pith, far denser and more luminous than the remaining part of the tail. *For along the middle of the tail* (they say) *there ran lengthwise a clear and evident line, like the pith of a tree.*

[Margin: Hujus phænomeni exemplum habemus in Cometâ an. 1618.] *We have an example of this phenomenon in the comet of the year 1618.*

The same thing likewise met the eyes of Kepler and Schickard at the same time, as the said Kepler attests in the *Physiology of Comets*, p. 103: *Just as in the comet of the year 1618 there was a certain inner nucleus, more solid and more luminous, so in the tail a single ray, in the likeness of the pith in a tree, was observed by the Romans at the beginning in the middle, and by me and Schickard on the later days towards one side: as if, as the whole tail from the whole head, so that conspicuous part of the tail had fallen away from the conspicuous nucleus of the head.*

[Margin: Quâ ratione nucleus inſtar medullæ producatur.] *How a nucleus is produced like a pith.*

The reasons for this phenomenon are in part evident from what we set out here and there above: namely, when the greatest part of the rays, reflected in

the head, gathers now on this side, now on that; and there those parts are then necessarily seen to be more splendid. But how a nucleus arises in the middle of the tail like a pith, I shall now also say: namely, when, around the beginnings of the comet's appearance, there is a very dense nucleus in the centre of the head which a little later splits open and breaks up into various particles, so that a space, or a kind of opening, is as it were opened and widened around the centre of the head. For if the rays are reflected towards one another through that widened opening from the surfaces of the corpuscles on the inside, the result is that in that place, namely, those solar rays accumulate more copiously, and are heaped together as it were into one heap, than towards either side, where such a suitable constitution of the head, or of its corpuscles, is then by no means found. From this it also came about that afterwards such a pith of the tail shone out, since in the comet of the year 1618, around its first appearance, there was only a single, very solid nucleus in the middle of the head, which had gradually, one part after another, broken up into various small portions, widening itself from the inner part. But I shall set out this opinion of mine somewhat more clearly by means of the figures annexed.

[Margin: Ex Schemate demonſtratur.] *It is demonstrated from the diagram.*

In the second drawing, let the head of the comet be endowed with one single and indeed rather compact nucleus, through which the passage of the solar rays, because of the solidity of that body, is impeded, and is open only to the sides and the periphery. Accordingly, those rays, carried off from the outer surface of that nucleus standing in the middle, and reflected outwards and, as it were, from the perpendicular, are by no means gathered together, but are rather dispersed and thrown out scattered in every direction, so that no pith at all can be generated; instead, a kind of fissure is shown in the tail in its place.

Diagram. An engraved figure across the full width of the text, standing between the fourth and fifth lines of the page. It has four numbered rows, one above another. In each row a rayed Sun stands at the left; two straight lines run from the top and bottom of the Sun's disc to the top and bottom of a comet's head at the right, and the comet's tail streams away to the right. In row 1 the head holds several dark clumps, and its dense tail ends at the upper right in an oval field of fine stippling. In row 2 the head holds a single dark round mass at its centre, and the tail is straight. In row 3 the head holds many small clumps, and the tail is straight. In row 4 the head holds small clumps set in a ring round a clear centre, and the tail curves downward. The engraver's signature stands at the lower right. Every label printed on the figure was read; none is left unread.

- 1 (between the Sun and the head, row 1): the numeral 1
- 2 (between the Sun and the head, row 2): the numeral 2
- 3 (between the Sun and the head, row 3): the numeral 3
- 4 (between the Sun and the head, row 4): the numeral 4
- Autòr ſculpsit. (lower right, engraved script): Engraved by the author.

[Margin: Quando in medio caudæ fisſura quædam conſpiciatur.] *When a kind of fissure is seen in the middle of the tail.*

[Margin: Quando verò nucleus appareat.] *But when a nucleus appears.*

But when the nucleus of the head has been widened, dispersed, that is, into smaller bodies, so that a fairly ample opening is formed near the centre — or if the head of the comet has been composed in that way right from the beginning, as the third figure shows — then, I say, the solar rays are not only transmitted abundantly through that opening, and indeed, reflected from every side, intersect one another in various ways, but are also gathered together, as it were, into one heap. So in that place, whether in the middle of the tail or in any other part of it where that accumulation of the solar rays then occurs, the coma necessarily appears brighter and thicker than in any other part of it, and indeed like an oblong nucleus, or pith. Moreover, it is also by no means contrary to reason that a similar phenomenon can sometimes occur in curved and arched tails as well, as we have shown drawn in the latter diagram.

[Margin: De Longitudinibus & Latitudinibus caudarum.] *On the lengths and breadths of tails.*

But I seem to have said enough about these matters for now. I come now to the lengths and breadths of the Tails, inquiring first whether they are seen at all times with the same length or with a different one; and how far the longest of all extend, according to appearance? As regards the first Question, it is more than sufficiently clear from what has gone before, above all from our History of Comets, that tails have been now shorter, now longer and wider.

[Margin: Quantæ ſint magnitudinis omnium longiſſimæ Cometarum caudæ.] *How great the longest tails of all comets are.*

For the splendour of the comet that Aristotle observed in the year 371 before the birth of Christ extended across a third part of the Heavens. The comet in the year 134 of the Christian era, in the reign of Attalus, of which Seneca makes mention, stretched out to an immense length and equalled that region of the Heavens which is named the Milky [Way]. Another, in the year 122 from the birth of Christ, by the testimony of Justinus, had occupied a fourth part of the Heavens with its size, and took four hours over its rising or its setting. Likewise the comet in the year 1264 after the birth of Christ sent out its rays with great light from the East as far as the middle of the Heavens, towards the west. The length of the one that Pontanus noted in the year 1456 was 60 ells, and that of another in the year 1460, 50 ells. The two that Appianus drew in the years 1531 and 1533 projected their Coma to 15°. The third of the same Author, however, [projected it] to 30°. Of the comet of the year 1577, which Tycho, of lofty genius, described accurately, the length of the tail had grown to 25°.

[Margin: Cometa 1618 caudam ferè omnium procerisſimam exbibuit.] *The comet of 1618 displayed almost the longest tail of all.*

The comet of the year 1618, however, surpassed nearly all in length, but at a set time, although from day to day it put on one appearance after another. On November 26, as Müllerus holds, it showed a tail of 90°; on December 9, according to Cysat, 75°. On December 10, as Longomontanus reports, the length of the tail stretched to 104°, so that in an astonishing and dreadful manner

it equalled a fourth, indeed almost a third, part of the Heavens. Certainly no comet like it (if you except Aristotle's) has ever blazed out since the founding of the world, so far as I know; the comet of the year 1652, on the other hand, bore a tail of only 7°.

[Margin: Cometarum alii perbrevi barbâ viſi ſunt.] *Some comets were seen with a very short beard.*

Again, others were very short: one displayed a coma scarcely a palm in length; another, half a degree; another, one whole degree. In the comet of 1585, and also in that of 1652 — namely on December 18, as Hilarius Spinellus and D. Christiani found — the length of the tail was seen to be no more than 1½°.

[Margin: Cauda omnium longiſſima,quot graduum extiterit.] *The longest tail of all: how many degrees it measured.*

From this it is clear that the tails of comets enjoy, as we have said, a most varied length, and indeed grow from one up to 104 degrees; but I have nowhere found that a greater one has ever existed — in degrees, that is.

[Margin: Vera Caudarum longitudo, ut apparens, admodùm eſt diverſa.] *The true length of Tails, like the apparent length, is very diverse.*

In semidiameters of the Earth, however, we also readily understand that they have displayed various lengths as well; although that true length of tails must be determined not according to the number of degrees, but according to the comets' genuine distance from the Earth. Therefore, if anyone wants the length of a tail in miles and semidiameters of the Earth, we must first have its true parallax — or, what comes to the same thing, its distance from the Earth — ascertained.

[Margin: Ex defectu obſervationum, vera longitudo omnium Cometarum explorari haud poteſt.] *For lack of observations, the true length of all the comets cannot be ascertained.*

Now it is indeed my intention — and it would by no means be unpleasant either — to present the tails of all the earlier comets computed in miles. But for most of them, since we do not know at what interval they stood removed from the earth, this can by no means be ascertained, except for the comets of the years 1577, 1590, 1607, 1618 and 1652: once their intervals are given, that is, the true length of the tails is known. As for the first, Tycho himself deduced it by calculation in Chapter IX: given, that is, the diameter of the comet's head as 210 semidiameters of the Earth, and the length of the apparent tail as 25°, its true length came to 95 semidiameters of the Earth, that is, 81,700 German miles. The tail of the comet of the year 1590, by our calculation — since in Tycho's view it was higher than the Sun, and its apparent length was 10° — comes out with a true length of the coma of 252½ semidiameters of the Earth, or 217100 in miles. The tail of the comet of 1607, at its least distance from the Earth of 449 semidiameters of the Earth, and with an apparent length of 10°, is found to be 82½ semidiameters of the Earth [S.T.], that is, 70,890 miles. But at the greatest

[Margin: Cauda Cometæ 1607 ſupra milleSemid.T. excreverat.] *The tail of the comet of 1607 had grown beyond a thousand semidiameters of the Earth.*

distance of it, 4588 semidiameters of the Earth, the tail runs out much further, namely to 1301 semidiameters of the Earth, or 1,119,000 German miles. The genuine length of the tail of the comet of the year 1618, however, we have computed for four different days of its appearance; the following little Table shows it.

[Margin: Vera caudæ longitudo Cometæ 1618.] *The true length of the tail of the comet of 1618.*

1618 December	True length of the tail in semidiameters of the Earth	True length of the tail in miles
1	32	27440
9	129½	111300
17	170	146200
29	242	208000

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[Margin: Quanta fuerit vera longitudo Cometæ 1652] *How great the true length of the comet of 1652 was*

It follows that we should finally also define the tail of the comet of the year 1652 accurately by calculation, and indeed for the individual days on which it was observed, so that it may be clear how the tail varied from day to day; and above all whether it really decreased, as indeed it did according to appearance, or rather grew towards its last appearance. For it is certain that something of this kind happened in the comet of the year 1618: for on December 29, although its apparent length was only 35°, the genuine length of the coma was nevertheless far greater than on December 9, when the apparent length equalled 75°, as the following calculation will show clearly.

[Margin: Quâ ratione vera longitudo caudæ exploretur.] *How the true length of a tail is ascertained.*

[The calculation] is set up, moreover, with the help of the accompanying diagram, in which S, the Sun, is the centre of the universe; T the Earth; T E F a portion of the great orb that carries the earth in its annual motion; C the head of the comet; A B the comet's rectilinear orbit; D the extremity of the tail; S T C the distance of the comet from the Sun; C T D the apparent length of the tail; S C T the angle at the comet between the Sun and the Earth; C D the length of the Tail; T C the interval of the comet from the Earth; T S the interval of the Sun from the Earth, and indeed according to our hypothesis; T D the interval of the extremity of the tail from the earth.

Diagram. An engraved figure in a faint rectangular frame, set at the left of the text with the description above running beside it. A straight base line runs from left to right, carrying F at its left end, S near its middle, and T and

[571] On the page this small ruled table stands at the left of the text, beside the opening of the next paragraph, with the side-notes in the margin beside it. Its heads read, column by column: *1618 Decemb.*; *Longitud. Caud. vera in Sem. Terræ.*; *Longitud. caudæ vera in mill.*

A towards its right. An arc rises from F, curves up through its highest point, marked E, and comes down to the base line at T. A long straight line runs from B, near the top of the figure, down through a small dark disc, the comet's head, marked C, to A on the base line. A shaded tail streams from the head up and to the right towards D. Straight lines join S to the head, T to the head, and T to D. The engraver's signature stands at the foot. Every label printed on the figure was read; none is left unread.

- E (top of the arc): E
- B (upper end of the long straight line): B
- D (upper right, at the end of the tail): D
- C (beside the comet's head): C
- F (left end of the base line): F
- S (middle of the base line): S
- T (base line, where the arc meets it): T
- A (base line, lower end of the long straight line): A
- Aut ſculps. (foot, engraved script): Engraved by the author.

In this way let us now ascertain, for eight different days — namely December 20, 23, 25, 26, 27, 30 and January 3 and 4, 1653 — the true length of the tail C D in semidiameters of the Earth, and also the interval of the extremity of the tail from the earth. And this indeed from the following givens: 1. the interval of the Sun from the earth, the least, 5063 semidiameters of the Earth, according to our opinion; 2. T C, the interval of the comet from the earth, already found above in Book V, page 316; 3. the distance of the comet from the Sun, or the angle S T C; and 4 the angle C T D, the observed length of the apparent tail.

Accordingly, in the plane oblique-angled triangle S T C, with the two sides S T and T C known, together with the included angle S T C, let the angle S C T at the comet between the Sun and the Earth be sought. The angle C T D — the observed length of the tail, that is — subtracted from this external angle leaves the other, internal and opposite, angle C D T.

Second and last, in the triangle T C D, from the known side C T — the interval of the comet from the Earth, that is — and all the angles, let the remaining two sides be sought, namely C D, the length of the tail, and D T, the interval of the extremity of the tail from the Earth, in semidiameters of the Earth. These semidiameters of the Earth I have converted into miles with the help of logarithms, since in this way the work is done both more easily and, because of the fractions, more accurately than by a simple multiplication by 860 miles. And it is done in this way: to the Logarithm of the true Length of the tail C D let the Logarithm belonging to 860 (for 1 semidiameter of the Earth) be added. Then the Logarithm of unity (if the sum of the Logarithms is of that size), or if not, the Logarithm of a thousand, or of a hundred, or of ten, is to be subtracted from the sum, so that the Logarithm of the tail sought comes out exactly in German miles, as has been done in the following calculation and as is usually done in the multiplication of Logarithms. It should be noted, however, that if you use those last three Logarithms, certain figures are then lacking and

must be added. Moreover, I would like you to know that in this investigation the tail is always assumed to be subject to no deviation at all from the straight path drawn from the Sun through the head of the comet. For since there is no need of such subtlety in this business, these matters have been willingly left aside. Even granting that all of them were to be taken into account, they could still contribute very little to the business in question; on the contrary, that procedure would make far more work for the investigator. I had to mention this here, so that no one should think this matter had never occurred to us.

Calculation for the length of the Tail of the Comet, in the year 1652 and 53 [Calculus pro longitudine Caudæ Cometæ Anno 1652 & 53.]

December 20 [Decembr. XX.][572]

For the distance of the comet from the Sun, S T C [Pro Diſtant. Comet. à Sole S T C.]

2ˢ 8° 44′ — *Longitude of the comet*
8ˢ 29° 39′ — *Longitude of the Sun*
158° 5′ — *Elongation of the comet from the Sun — Ant.* 7041
30° 49′ — *Latitude — southern — Alg.* 15,221 *A.*
143° 10′ — S T C — *distance of the comet from* ⊙ [the Sun] — *Alg.* 22,262
36° 50′ — O T C — *equal to the two, C S T and S C T*
18° 25′ — *half of the sum of the angles*

For the angle S C T [Pro angulo S C T.]

5063 — *semidiameters of the Earth* — S T — *interval of the Sun from the Earth*
110 — C T — *interval of the comet from the Earth*
4953 — *difference — Logarithm* 70258
5173 — *sum — Logarithm* 65911 *S.*
Indic. Logarithm + 4347
18° 25′ — *half-sum of the angles — Mlg.* + 109,968 *A.*
A. 17° 41′ — *difference of the angles — Mlg.* + 114,315
36° 6′ — S C T — *angle at the comet*
7° 0′ — C T D — *observed length of the tail*
29° 6′ — T D C

For the true length of the Tail, C D [Pro longitud. verâ Caudæ C D.]

110 — *semidiameters of the Earth* — C T — *Logarithm* 450986
7° 0′ — C T D — *Logarithm* 210480 *A.*
Sum 661,466
29° 6′ — T D C — *Logarithm* 72086 *S.*
27½ — *semidiameters of the Earth* — C D — *length of the tail — Logarithm* 589380
860 — *miles for a true semidiameter of the Earth — Logarithm* 245342 *A.*
C D — *Mutil. 4. not. — Logarithm* 834722

[572] On the page the calculation below this caption is set in two columns side by side, without a ruled grid, with short rules under the figures that are added or subtracted. The left column is given first, then the right column. In the left-hand groups the column heads *S.*, ° and ′ stand for signs, degrees and minutes.

Ascitit. III — 690,775 *S.*
23700 — *miles* — C D — *length of the tail* — *Logarithm* 143947
For the interval of the extremity of the tail from the Earth, T D [Pro Intervall. Extrem. Caud. à Terrâ T D.]
110 — *semidiameters of the Earth* — C T — *Logarithm* 450986
36° 6′ — S C T — *Logarithm* 52900 *A.*
Sum 503,886
29° 6′ — T D C — *Logarithm* 72086 *S.*
133 — *semidiameters of the Earth* — T D — *interval of the tail* — *Logarithm* 431800
On December 23 [Die Decemb. XXIII.]
For the distance of the comet from the Sun, S T C [Pro distant. Comet. à Sole S T C.]
1^{s} 29° 24′ — *Longitude of the comet*
9^{s} 2° 43′ — *Longitude of the Sun*
156° 41′ — *Elongation of the comet from the Sun* — *Alg.* 17,955
3° 2′ — *Latitude* — *southern* — *Alg.* 140 *A.*
146° 34′ — S T C — *distance of the comet from* ⊙ — *Alg.* 18,095
33° 26′ — O T C
16° 43′ — *half*
For the angle S C T [Pro Angulo S C T.]
5063 — *semidiameters of the Earth* — S T
114 — C T
4949 — *difference* — *Logarithm* 70340
5177 — *sum* — *Logarithm* 65835 *S.*
Indic. — *Logarithm* + 4505
16° 43′ — *half-sum* — *Mlg.* + 120,287 *A.*
A. 16° 1′ — *difference of the angles* — *Mlg.* + 124,792
32° 44′ — S C T
S. 5° 0′ — C T D
27° 44′ — T D C
___[573]
For the length of the tail C D, on December 23
114 *semidiameters of the Earth, C T* — *Logar.* 447414 5° 0′ *C T D* — *Logar.* 244006 *A. Sum* — 691,420 27° 44′ *T D C* — *Logar.* 76495 *S.* 21⅓ *semidiameters of the Earth, C D, length of the tail* — *Logar.* 614925 860 *miles* — *Logar.* 245342 *A. C D, Mutil. not.* 4. — *Logar.* 860267 *Ascitit.* III — 690,775 *S.* 18360 *miles, C D* — *Logar.* 169492
For the interval of the end of the tail from the Earth, T D [Pro Intervall. Extrem. Caudæ à Terrâ T D.]

[573] The page is set in two columns of calculation. The left column is given first, then the right.

114 *semidiameters of the Earth, C T — Log.* 447414 32° 44′ *S C T — Log.* 61484 *A. Sum —* 508,898 27° 44′ *T D C — Log.* 76495 *S.* 132 *semidiameters of the Earth, T D — Log.* 432403

December 25

For the distance of the comet from the Sun, S T C [S. ° ′ Pro diſtant. Comet. à Sole S T C.]

1^{s} 26° 2′ *— longitude of the comet* 9^{s} 4° 45′ *— longitude of the Sun* 141° 17′ *— elongation of the comet from the Sun — Alg.* 24,351 8° 41′ *— northern latitude — Alg.* 1153 *A.* 140° 48′ *— S T C — Alg.* 25,504 39° 12′ *— O T C* 19° 36′ *— half*

For the angle S C T [Pro Angulo S C T.]

5063 *semidiameters of the Earth, S T* 146 *C T* 4917 *difference — Log.* 70988 5209 *sum — Log.* 65219 *S. Indic. Log.* + 5769 19° 36′ *half-sum — Mlg.* + 103,259 *A. A.* 18° 35′ *angle of difference — Mlg.* + 109,028 38° 11′ *S C T S.* 1° 30′ *C T D* 36° 41′ *T D C*

For the true length of the tail, C D [Pro longit. verâ Caud. C D.]

146 *semidiameters of the Earth, C T — Log.* 422673 1° 30′ *C T D — Log.* 364287 *A. Sum —* 786,960 36° 41′ *T D C — Log.* 51518 *S.* 6⅖ *semidiameters of the Earth, C D — Log.* 735442 860 *miles — Log.* 245342 *A.* 980,784 921,034 *S.* 5502 *miles, C D — Log.* 59750

For the distance of the end of the tail from the Earth, D T [Pro diſtant. Extrem. Caud. à Terr. D T.]

146 *semidiameters of the Earth, C T — Log.* 422673 38° 11′ *S C T — Log.* 48098 *A. Sum —* 470,771 36° 41′ *T D C — Log.* 51518 *S.* 151 *semidiameters of the Earth, T D — Log.* 419253

December 26

For the distance of the comet from the Sun, S T C [S. ° ′ Pro diſtant. Comet. à Sole S T C.]

1^{s} 24° 42′ *— longitude of the comet* 9^{s} 5° 47′ *— longitude of the Sun* 138° 55′ *— elongation of the comet from the Sun — Alg.* 28,269 13° 4′ *— northern latitude — Alg.* 2623 *A.* 137° 15′ *— S T C — Alg.* 30,892 42° 45′ *— O T C* 21° 23′ *— half*

For the angle S C T [Pro angulo S C T.]

5063 *semidiameters of the Earth, S T* 189 *C T* 4874 *difference — Log.* 71865 5252 *sum — Log.* 64397 *S. Indic. Log.* + 7468 21° 23′ *half-sum — Mlg.* + 93,762 *A. A.* 19° 58′ *angle of difference — Mlg.* + 101,230 41° 21′ *S C T S.* 2° 0′ *C T D* 39° 21′ *T D C*

For the true length of the tail, C D [Pro longit. verâ caudæ. C D.]

189 *semidiameters of the Earth, C T — Log.* 396859 2° 0′ *C T D — Log.* 335528 *A.* 732,387 39° 21′ *T D C — Log.* 45562 *S.* 10⅖ *semidiameters of the Earth, C D — Log.* 686825 860 *miles — Log.* 245342 *A.* 932,167 921,034 *S.* 8946 *miles, C D — Log.* 11133

For the interval of the end of the tail from the Earth, T D [Pro Intervall. Extrem. caud. à Terrâ. T D.]

189 *semidiameters of the Earth, C T — Log.* 396859 41° 21′ *S C T — Log.* 41452 *A. Sum —* 438,311 39° 21′ *T D C — Log.* 45562 *S.* 197 *semidiameters of the Earth, T D — Log.* 392749

December 27

For the distance of the comet from the Sun, S T C [S. ° ′ Pro diſtant. Comet. à Sole S T C.]

1^{s} 23° 35′ *— longitude of the comet* 9^{s} 6° 48′ *— longitude of the Sun* 136° 47′ *— elongation of the comet from the Sun — Alg.* 31,640 16° 36′ *— northern latitude — Alg.* 4257 *A.* 134° 18′ *— S T C — Alg.* 35,897 45° 42′ *— O T C* 22° 51′ *— half*

For the angle S C T [Pro angulo S C T.]

5063 *semidiameters of the Earth, S T* 265 *C T* 4798 *difference — Log.* 73437 5328 *sum — Log.* 62959 *S. Indic. Log.* + 10478 22° 51′ *half-sum of the angles — Mlg.* + 86,420 *A. A.* 20° 47′ *angle of difference — Mlg.* + 96,898 43° 38′ *S C T S.* 4° 0′ *C T D* 39° 38′ *T D C*

For the true length of the tail, C D [Pro longit. verâ caud. C D.]

265 *semidiameters of the Earth, C T — Log.* 363061
4° 0′ *T C D — Log.* 266274 *A.*
Sum — 629,335
39° 38′ *T D C — Log.* 44962 *S.*
29 *semidiameters of the Earth, C D — Log.* 584373
860 *miles — Log.* 245342 *A.*
829,715
690,775 *S.*
24920 *miles, C D — Log.* 138940

For the interval of the tail from the Earth, D T [Pro Intervall. caudæ à Terrâ D T.]

265 *semidiameters of the Earth, C T — Log.* 363061
43° 38′ *S C T — Log.* 37100 *A.*
Sum — 400,161
39° 38′ *T D C — Log.* 44962 *S.*
287 *semidiameters, T D — Log.* 355199

December 30

For the distance of the comet from the Sun, S T C [S. ° ′ Pro diſtant. Com, à Sole. S T C.]

1^{s} 21° 28′ *— longitude of the comet*
9^{s} 9° 52′ *— longitude of the Sun*
131° 36′ *— elongation of the comet from the Sun — Alg.* 40,958
23° 25′ *— northern latitude — Alg.* 8595 *A.*
127° 32′ *— S T C — Alg.* 49,553
52° 28′ *— O T C*
26° 14′ *— half*

For the angle S C T [Pro angulo S C T.]

5063 *semidiameters of the Earth, S T*
817 *C T*

4246 *difference — Log.* 85659
5880 *sum — Log.* 53103 *S.*
Indic. Log. + 32556
26° 14′ *half — Mlg.* + 70,768 *A.*
A. 19° 35′ *angle of difference — Mlg.* + 103,324
45° 49′ *S C T*
S. 1° 0′ *C T D*
44° 49′ *T D C*

For the true length of the tail, C D [Pro longitud. verâ caud. C D.]

817 *semidiameters of the Earth, C T — Log.* 250470
1° 0′ *C T D — Log.* 404828 *A.*
Sum — 655,298
44° 49′ *T D C — Log.* 34978 *S.*
20¼ *semidiameters of the Earth, C D — Log.* 620320
860 *miles — Log.* 245342 *A.*
865,662
690,775 *S.*
17400 *miles, C D, length of the tail — Log.* 174887

For the interval of the tail from the Earth, D T [Pro Intervall. caudæ à Terrâ D T.]

817 *semidiameters of the Earth, C T — Log.* 250470
45° 49′ *S C T — Log.* 33252 *A.*
Sum — 283,722
44° 49′ *T D C — Log.* 34978 *S.*
831 *semidiameters of the Earth, T D — Log.* 248744

January 3

For the distance of the comet from the Sun, S T C [S. ° ′ Pro diſtant. Com. à ☉ S T C.]

1^{s} 20° 4′ *— longitude of the comet*
9^{s} 13° 57′ *— longitude of the Sun*
126° 7′ *— elongation of the comet from the Sun — Alg.* 52,860
28° 42′ *— northern latitude — Alg.* 13,108 *A.*
121° 8′ *— S T C — Alg.* 70,968
58° 52′ *— O T C*
29° 26′ *— half*

For the angle S C T [Pro angulo S C T.]

5063 *semidiameters of the Earth, S T*
3000 *C T*
2063 *difference — Log.* 157841
8063 *sum — Log.* 21528 *S.*
Indic. Log. + 136313
29° 26′ *half — Mlg.* + 57,228 *A.*
A. 8° 13′ *angle of difference — Mlg.* + 193,541
37° 39′ *S C T*

S. 2° 0′ *C T D*
35° 39′ *T D C*
For the true length of the tail, C D [Pro longitud. verâ caud. C D.]
3000 *semidiameters of the Earth, C T — Log.* 120397
2° 0′ *C T D — Log.* 335528 *A.*
Sum — 455,925
35° 39′ *T D C — Log.* 53986 *S.*
180 *semidiameters of the Earth, C D — Log.* 401939
860 *miles — Log.* 245342 *A:*
647,281
460,517 *S.*
154500 *miles, C D — Log.* 186764
For the interval of the tail from the Earth, D T [Pro Intervall. caudæ à Terrâ D T.]
3000 *semidiameters of the Earth, C T — Log.* 120397
37° 39′ *S C T — Log.* 49293 *A.*
Sum — 169,690
35° 39′ *T D C — Log.* 53986 *S.*
3144 *semidiameters, T D — Log.* 115704
January 4
For the distance of the comet from the Sun, S T C [S. ° ′ Pro diſtant. Com. à ☉ S T C.]
1^{s} 19° 52′ *— longitude of the comet*
9^{s} 14° 59′ *— longitude of the Sun*
124° 53′ *— elongation of the comet from the Sun — Alg.* 55,878
29° 40′ *— northern latitude — Alg.* 14,050 *A.*
119° 48′ *— S T C — Alg.* 69,928
60° 12′ *— O T C*
30° 6′ *— half*
For the angle S C T [Pro angulo S C T.]
5063 *semidiameters of the Earth, S T*
3957 *C T*
1106 *difference — Log.* 220182
9020 *sum — Log.* 10314 *S.*
Indic. Log. + 209868
30° 6′ *half — Mlg.* + 54,528 *A.*
A. 4° 4′ *angle of difference — Mlg.* + 264,396
34° 10′ *S C T*
S. 1° 30′ *C T D*
32° 40′ *T D C*
For the true length of the tail, C D [Pro longit. verâ caudæ C D.]
3957 *semidiameters of the Earth, C T — Log.* 92709
1° 30′ *C T D — Log:* 364,287 *A.*
Sum — 456,996

32° 40′ *T D C — Log.* 61665 *S.*
192 *semidiameters of the Earth, C D — Log.* 395331
860 *miles — Log.* 245342 *A.*
640,673
460,517 *S.*
165000 *miles, C D — Log.* 180156

For the interval of the tail from the Earth, D T [Pro Intervall. caud. à Terr. D T.]

3957 *semidiameters of the Earth, C T — Log.* 92709
34° 10′ *S C T — Log.* 57696 *A.*
Sum — 150,405
32° 40′ *T D C — Log.* 61665 *S.*
4117 *semidiameters of the Earth, T D — Log.* 88740

[Margin: Quomodo vera longitudo Caudæ variaverit, Cometæ 1652.] *How the true length of the tail varied, comet of 1652.*

I have gathered the result of this computation into the small table attached, so as to set before the eyes, at a single glance, each of the lengths of the tail and the manner in which they varied.

Day of the month [Dies Menf.]	Apparent length of the tail, C T D	True length of the tail, C D, in semidiameters of the Earth	True length of the tail, C D, in German miles
December 20	7° 0′	27½	23700
23	5° 0′	21½	18360
25	1° 30′	6⅘	5502
26	2° 0′	10⅖	8946
27	4° 0′	29	24920
30	1° 0′	20¼	17400
January 3	2° 0′	180	154500
4	1° 30′	192	165000

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[Margin: Caudæ variatio veræ longitudinis, non æmulatur variationem longitudinis apparentis.] *The variation of the tail's true length does not follow the variation of its apparent length.*

It is therefore plain that the true length of the tail was not equal throughout the whole time of the appearance, but very different. You will no doubt persuade yourself that this could not by necessity have happened otherwise, since the apparent length likewise varied from day to day in its degrees. But to grasp the matter rightly, you must know that this variation of the true length

574 On the page the table stands at the left of the text block, beside the paragraph that follows, which is set to a narrow measure at its right. The heads are set over four lines; the apparent length is given under the sub-heads Grad. and Min. (degrees and minutes), here joined in one column. Horizontal rules divide the rows into three groups: December 20–25, December 26–30, January 3–4. No row stands below the last.

of the tail by no means follows the variation of the apparent length, but draws its increases and decreases from quite other causes. For on December 25, when the apparent length of the tail was 1° 30′, the true length was found to be 6⅘ semidiameters of the Earth; again, on January 4, when the same apparent length was shown, the true length equalled 192 semidiameters of the Earth. That is truly an enormous difference and ratio. Indeed, it is not rare that, when the tail is even very short as to the apparent [length], its true length is very long; and conversely, when the apparent length is exceedingly long, the true length is nevertheless very short.

[Margin: Quibus de cauſis vera longitudo caudæ varietur.] *From what causes the true length of the tail varies.*

The chief reason for this phenomenon is that the variation of the tail in its true length arises from two causes, and those dissimilar. First, from the greater or smaller distance of the comet from the Earth. For in a more remote position (as we have found) the tail necessarily appears shorter than in a nearer one, even though in reality it is of equal size at either elongation, because of the smaller angle of vision under which the tail is seen. Second, the true increase and decrease of the tail vary with the rarity and density of the consistency poured around it, that is, of the matter that surrounds and accompanies the comet.

[Margin: Pro quantitate Atmoſphæræ Cometicæ,vera longitudo caudæ creſcit.] *The true length of the tail grows with the quantity of the comet's atmosphere.*

For in so far as this matter grows and diminishes, expands and contracts, to that extent the true length of the tail is increased or diminished, as we have already touched on above and as will also be said more fully in its place.

[Margin: Apparens verò pro variâ digreſſioneCometæ àSole maximè variatur.] *But the apparent [length] varies most of all with the comet's varying digression from the Sun.*

But the apparent tail varies not only for the reasons given, but also, and chiefly, from the varying distance, or digression, from the Sun. For the nearer to the Sun, or the more remote, the comet is in the circle of distance (that is, the angle at the Earth by the lines to the Sun, and to the comet enclosed, is greater or smaller), the shorter or longer the tail appears; sometimes it even vanishes altogether, although in reality the comet has a very long tail. Above all, it adds not a little to this effect when the interval of the comet from the Earth grows or diminishes, and also when it comes to equal the very interval of the Sun from the Earth.

[Margin: Melioris intellectus gratiâ Schemate declarantur omnia.] *For better understanding, everything is set out in a diagram.*

Since not everyone grasps this equally clearly, however, I shall demonstrate it all graphically (above all with this in view: that very pleasing questions arising from it can likewise be resolved at the same time), and that at five different digressions from the Sun. Namely: first, when the interval of the comet from the Earth is twice as great as the interval of the Sun; second, when the comet and the Sun are equally removed from the Earth; third, when the comet lies at

the middle distance between the Sun and the Earth; fourth, when the comet is distant from the Earth by a quarter of the Sun's distance from the Earth; and fifth, when it is removed from the Earth by only 300 semidiameters of the Earth. Namely, in what ratio does this compare with the apparent length of the tail? How does it vary, and where does the tail appear largest of all? The true length of the tail is given as constantly 400 semidiameters of the Earth.

[Margin: Elucidatio Schematis.] *Explanation of the diagram.*

In the attached diagram, then, let T be the Earth, S the Sun; C the head of the comet; D the end of the tail; C D the true length of the tail; the angle of vision D T C; the apparent magnitude of the tail T S; the interval of the Sun from the Earth, according to our view, 5063; T C the interval of the comet's head from the Earth; T D the interval of the end of the tail from the Earth; circle M, the interval of the comet from the Earth, double that of the Sun; circle L equal to the ecliptic; circles I in the ratio of one half with respect to circle L; and H in the ratio of one quarter; and the inner circle T, distant from the Earth 300 semidiameters of the Earth, whose radius is to be smaller than the length of the tail.

Diagram. An engraved figure set across the text block, inside the paragraph above (between the words inter- and vallum). The Earth stands at the centre of a horizontal base line, with concentric semicircles drawn above it; a rayed Sun stands on the base line left of centre. Comets, drawn as dark heads with feathered tails, are set on the semicircles at many elongations, each joined to the centre by a line to its head and a line to the end of its tail. The labels engraved on the figure:

- C (27 instances): the comet heads, on every semicircle.
- D (24 instances): the tail ends; the two lowest comets on the outermost semicircle at the left, and three small comet heads near the centre, carry none.
- A (upper left, beside a comet on the outermost semicircle) and B (beside the comet just above the Sun).
- E, and above it a letter that is E or F [?], beside comets within the inner semicircles.
- S (italic, beside the Sun).
- M, L, I (each twice, at the two feet of the outermost, second and third semicircles on the base line).
- *Autor ſculpsit.* (lower right, in script): Engraved by the author.

No letter T stands at the Earth and no letter H appears on the figure, though the paragraph cites both; the two innermost circles carry no letter at their feet. The counts of C and D are a floor.

[Margin: Pro variâ diſtantiâ Cometæ à Terrâ,& angulo viſionis, cauda apparens nunc major,nunc minor eſt; licet vera longitudo ſemper ſit eadem.] *According to the comet's varying distance from the Earth and the angle of vision, the apparent tail is now greater, now smaller, although its true length is always the same.*

In these circles, then, which lie at various distances from the Earth, various tailed comets move. Although their tails have been drawn somewhat longer on the outer circles, for the sake of better understanding, I would nevertheless have you take them all as though they were of the same length. Even so, on any circle whatever and at the comet's various digressions from the Sun, they do not present altogether the same face, or length, as regards the appearance of the tail. For the circle of vision D T C is greater or smaller (according as the comet is nearer to the Sun or more remote), and indeed in a ratio peculiar to each circle; so that the tail does not appear greatest perpetually, at every digression of the comet from the Sun, but, according as the interval of the comet from the Earth is greater or smaller, is seen most extended now at this digression from the Sun, now at that.

[Margin: Quibus in locis etiam omnium longiſſimæ caudæ evaneſcant.] *In which places even the longest tails of all vanish.*

Moreover, in some places and positions of the comet relative to the Sun, or at a certain aspect of the Sun, the tails of comets, although in reality they are very long, are entirely extinguished: namely, at the very conjunction and opposition of the comet and the Sun, whether the comets stand below the Sun or above it, provided they wholly lack any perceptible latitude. There, I say, not even a particle of the tail falls under sight, as can be seen at M, L and I, in opposition, and also in conjunction, that is, in the opposite region. For there the angle of vision D T C, under which the apparent tail is otherwise detected, vanishes entirely, and the two lines T D and T C, which form that angle, coincide entirely in one and the same straight line.

[Margin: Quo in loco caput Cometæ totam caudam abſcondere, & quaſi eclipſare poſit. Rursùs quando,& quomodo hirſutus Cometa appareat.] *In which place the head of the comet can hide the whole tail and, as it were, eclipse it. Again, when and how a comet appears shaggy.*

So in those places the head of the comet entirely absorbs, or hides, the whole tail (provided, that is, this tail does not exceed the head in its breadth, nor is broader in any part of it, but is narrower than the head from its very issue right to its end). But if the tail is somewhat broader than the head itself, then the head appears as if surrounded by the tail, and is seen as haired, or shaggy: such an appearance of the comet as I chose to sketch in the drawing on page 442 of this book. And in the year 1618 [a comet] also appeared entirely so in the sky itself; Mästlin above all observed it carefully, and describes it thus: *On October 2, when it was first seen by me, it lacked any tail, having a round shape, surrounded all round with hair.* Page 13.

[Margin: Quomodo barbam acquirat.] *How it acquires a beard.*

But when the comet digresses a very little from the Sun, the tail at once shoots out from one side, according to its true length, and the comet then becomes bearded, displaying as it were a short beard, or coma: like the comet that was at times seen so in the year 1585, and also the comet of the year 1652,

which shone out on December 18, a little after its conjunction with the Sun. Very many others, too, have been of this kind.

[Margin: Mira Cometarum metamorphoſis nonnunquam contingit.] *A remarkable metamorphosis of comets sometimes occurs.*

From these it is again clearly recognised that from a tailed comet a round and haired one can arise, and conversely from a haired and disc-shaped one a comet with a very long tail, like a spear or a spit, etc. Some, therefore, lose their tail, others acquire one; some, however, earlier, others later, according to the position of each relative to the Sun and its distance from the Earth. Of such comets, no less, very many examples are ready to hand, which I gladly pass over here.

[Margin: In diſtantiâ Cometæ à terrâ duplâ, reſpectu Solis, quâ ratione cauda apparẽs varietur.] *At a distance of the comet from the Earth double that of the Sun, in what ratio the apparent tail varies.*

But the farther the comet departs from the conjunction with the Sun on circle M, namely at an interval double that of the Sun, the longer the apparent coma is seen; up, however, to about the sextile aspect, that is, or to degree six- ty of digression from the Sun, namely at A. Then, as it departs farther and farther from the Sun, even though it nourishes a very long coma, its apparent length suddenly decreases more and more; and the more it inclines toward the opposition of the Sun, the shorter the tail becomes, until at the opposition itself, as we have just said, it withdraws entirely from sight. Moreover, the tails grow very quickly from the conjunction up to 60 degrees, but afterwards very slowly up to the opposition.

[Margin: Sub hoc intervallo, in adſpectuSextili cauda apparens omnium eſt longiſſima.] *At this interval, in the sextile aspect, the apparent tail is the longest of all.*

To this extent, therefore, the tail (namely when the comet is twice as far from the Earth as the Sun, and the true length of the tail remains always the same; otherwise this rule would certainly not be without many exceptions) is seen greatest of all at a digression of 60 degrees from the Sun, or at about the sextile aspect: namely when the angle at the Sun, or the angle which the solar rays directed at the comet [form], makes a right angle with those rays which are projected onto the Earth.

[Margin: Certa axiomdta, pro videnâ caudâ longiſaſimâ.] *Certain axioms for seeing the tail at its longest.*

Hence, the greater the comet's interval is, the nearer to the quadrant; and the smaller that interval of the Sun, of the comet from the Sun, is, the nearer to the Sun does that distance of the comet from the Sun approach which is required for seeing the tail at its longest. Moreover, the more the comet's interval from the Earth exceeds the solar interval, the shorter the tail appears (on this express condition, however, that it continually keeps the same length); and where the comet's interval equals the Sun's, there it appears longer.

[Margin: QuandoCometa non remotior Sole exiſtit, cauda eò longior, quò Soli propior eſt.] *When the comet is not more remote than the Sun, the tail is the longer the nearer it is to the Sun.*

But when the comet is carried by its proper motion at as great an interval from the Earth as the Sun itself stands, and on circle L, things are arranged quite differently: for the tail is the longer the nearer it is to the Sun. And hence, the farther it is removed from the Sun, the shorter the tail appears; and as it recedes in this position it decreases successively and gradually all the way to the opposition itself, as becomes plain to anyone who looks into the figure more closely.

[Margin: Paradoxon.] *A paradox.*

We did say above that at the very conjunction with the Sun no tail is seen; and this, indeed, is entirely contrary to the statement that at an equal elongation of the comet and the Sun from the Earth the coma ought to be the longest of all. But I would not have you understand our words as if I had said at the very conjunction of the Sun; rather, that the tail is seen at its longest when the comet is nearest the Sun.

[Margin: Quâ in diſtantiâ, Cometa ad ipſam conjunctionem Solis pervenire haud poſſit.] *At what distance the comet cannot reach the very conjunction of the Sun.*

For at an exactly equal elongation of the comet and the Sun from the Earth, the comet is never (if we weigh the matter accurately) given access to reach the conjunction; otherwise, surely, since both bodies would enjoy a like altitude and latitude, one body would penetrate the other, which would certainly be most absurd.

[Margin: In diſtantiâ Cometæ à terrâ minori, cauda apparet longiſſima priusquam 90 grad. à Sole digreditur.] *At a smaller distance of the comet from the Earth, the tail appears longest before [the comet] digresses 90 degrees from the Sun.*

For the rest, let the comet's interval from the Earth be less than the interval of the Sun: the tail appears greatest before the comet's digression from the Sun reaches the quadrant of the circle, namely at the moment when the comet's tail makes a right angle with the line of sight directed to its extremity. For example: when the comet's removal from the Earth is one half of the Sun's distance, namely on circle I, the tail shines at its tallest at a distance of the comet from the Sun of 51° 19′, at E; up to that point, beginning from the conjunction itself, the coma grows continuously, and indeed fairly quickly, as to appearance; but then it decreases gradually up to the opposition.

[Margin: In diſtantiâ Cometæ, reſpectu Solis ſubquadruplâ, ubinam detur cauda proceriſſima ?] *At a distance of the comet one quarter of the Sun's, where is the tallest tail found?*

Finally, when the comet's interval from the Earth is given in the ratio of one quarter with respect to the Sun, the tail is again seen at its most extended under the sextile aspect, or, to speak more accurately, at a distance of the comet from the Sun of 57° 12′, as is clear at F;

thereafter it is at once attenuated, and indeed in this proportion: the smaller the comet's interval from the Earth, and also the shorter its tail, the nearer to the quadrant does the distance of the comet from the Sun approach that is required for the tail to be displayed at its longest.

[Margin: Longitudo apparens caudæ longisſimæ in diſtantiâ 100 Semid. T. à Terrâ.] *The apparent length of the longest tail at a distance of 100 semidiameters of the Earth from the Earth.*

For example: let the true length of the tail be only 3 semidiameters of the Earth, and the comet's interval 50 semidiameters of the Earth; in that case the tail is seen at its tallest at a distance of the comet from the Sun of 86 degrees, although in its length it does not exceed 3° 26′. But if the interval is 100 semidiameters of the Earth, the most extended tail would equal only 1° 43′, but at a distance from the Sun of 87° 10′: nearer to the quadrant than this the place cannot be given where, namely, the tail could grow out longer, unless perhaps you suppose a still smaller true length of the tail at a corresponding interval, as one of the following tables will clearly show.

[Margin: Quâ ratione cauda longisſima in ipsâ conjunctione Solis appareat.] *How the longest tail appears at the very conjunction of the Sun.*

Lastly, when the length of the tail itself exceeds the comet's interval from the Earth, then the nearer the comet is in conjunction with the Sun, the greater the apparent tail is; so much so that at the very conjunction of the Sun the comet's tail, passing across the Earth and touching it, would appear of infinite length, if only it were possible to see it then through the solar rays. The same drawing above shows this at T, the smaller little circle: where the true length of the tail is given as 400 semidiameters of the Earth and the comet's interval as only 300 semidiameters of the Earth, there the tallest tail, near the Sun itself, indeed at the very conjunction (if the comet happened to be seen by day, which however can hardly be), would grow out to fully 180 degrees, and would then seem to be thrown across not far from the Earth, like an extremely long fiery ray subtending the whole hemisphere.

[Margin: Certo in poſitu cauda apparens longisſima ad 180 grad. excurrere poteſt.] *In a certain position the longest apparent tail can extend to 180 degrees.*

But afterwards, when the comet had digressed only a very little from the Sun, the tail would at once decrease and diminish very rapidly, sooner than one would expect.

When all this has been attentively considered, I think it is no longer hidden from anyone in what ratio the tail varies at different distances from the Earth and the Sun, and also where and when it ought to appear greatest.

[Margin: Quando Cometæ in altisſimo æthere verſantur,ubi diſtantia Solis ad intervallum Cometæ penitùs evaneſcit; ibidem quovis loco omnẽ omninò exuunt Comam, ut ut reverà maximam alat.] *When comets move in the highest aether, where the distance of the Sun vanishes entirely in comparison with the comet's interval, there, in any place whatever, they shed their coma entirely, however great a one it may in truth nourish.*

But before we leave this point, it must be noted that in those immense removals of the comet from the Earth, when it is carried far, far above the Sun in the highest aether, so that the interval of the Sun from the Earth almost vanishes in comparison with it, at that time, I say, the comet shows scarcely any tail, even though it be endowed with the greatest [tail] of all; and this always, at all distances and aspects of the comet and the Sun, whether it stands in quadrature, in sextile, or in opposition. For that reason none of the comets, once they move higher than the Sun, displays an extended tail, of all those, however many, that our predecessors have ever handed down to memory.

[Margin: Singulas iſtas variationes caudæ, in diverſis illis diſtantiis & àSole digreſſionibus, Autor ſedulò ſupputatas in tabellam retulit.] *The author has carefully computed each of these variations of the tail, at those different distances and digressions from the Sun, and entered them in a table.*

But so that everything just said, and explained with the help of the preceding figure on page 525, may be set before the eyes still more clearly, we have deliberately computed, by a more accurate calculation, how the apparent tails change, grow and decrease at those elongations of the comet from the Earth mentioned before, and indeed at each ten degrees of the comet's distance from the Sun, beginning from the conjunction up to the opposition itself; at what digressions and distances from the Sun they are greatest; likewise how many degrees they appear to equal in all those places, always supposing the same true length of the tail, 400 semidiameters of the Earth; or how great the angle is in any position of the tail relative to the Sun.

[Margin: Tabellæuſus.] *The use of the table.*

These, I say, we have transcribed into the attached table: both so that at a single glance you may grasp the matter at once, and also so that you may conveniently use them in other apparitions of comets, in which the interval from the Earth and the distance from the Sun have already been ascertained, to recognize in which place the tail will appear at its longest. The first small column of the table, on the left, shows the distances of the comet from the Sun at every ten degrees; the second, the angle S C T at the comet; the third, the apparent length of the tail, given an interval of the comet from the Earth of only 300 semidiameters of the Earth. Next there follow here the same angle and the apparent length of the tail at an interval one quarter of the Sun's; and so on for all the remaining intervals.

Table showing the variation of a comet's tail for different positions relative to the Sun, always supposing the same true length of the tail, 400 semidiameters of the Earth.

Interval from the Earth: distance of the comet from the Sun (degrees)	Less than the length of the tail, 300 semidiameters of the Earth: angle at the comet, S C T	Same: apparent length of the tail	One quarter of the Sun's, 1266 semidiameters of the Earth: angle at the comet, S C T	Same: apparent length of the tail	Half of the Sun's, 2532 semidiameters of the Earth: angle at the comet, S C T	Same: apparent length of the tail	Equal to the Sun's, 5063 semidiameters of the Earth: angle at the comet, S C T	Same: apparent length of the tail	Double the Sun's, 10126 semidiameters of the Earth: angle at the comet, S C T	Same: apparent length of the tail
10	169° 22′	141° 36′	166° 42′	6° 0′	160° 17′	3° 35′	85° 0′	4° 28′	9° 43′	0° 22′
20	158° 46′	116° 42′	153° 37′	11° 4′	142° 7′	6° 19′	80° 0′	4° 23′	17° 53′	0° 40′
30	148° 13′	100° 47′	140° 56′	14° 47′	126° 12′	8° 0′	75° 0′	4° 17′	23° 48′	0° 53′
40	137° 43′	89° 7′	128° 45′	17° 4′	112° 29′	8° 50′	70° 0′	4° 8′	27° 31′	1° 1′
50	127° 18′	79° 44′	117° 8′	18° 11′	100° 34′	9° 5′	65° 0′	3° 58′	29° 26′	1° 5′
60	116° 58′	71° 36′	106° 6′	18° 24′	90° 0′	8° 59′	60° 0′	3° 46′	30° 0′	1° 6′
70	106° 45′	64° 15′	95° 36′	18° 0′	80° 27′	8° 38′	55° 0′	3° 33′	29° 33′	1° 5′
80	96° 38′	57° 26′	85° 34′	17° 5′	71° 40′	8° 8′	50° 0′	3° 18′	28° 20′	1° 2′
90	86° 36′	50° 58′	75° 59′	15° 54′	63° 26′	7° 31′	45° 0′	3° 2′	26° 34′	0° 59′
100	76° 42′	44° 48′	66° 43′	14° 28′	55° 38′	6° 50′	40° 0′	2° 45′	24° 22′	0° 54′
110	66° 52′	38° 50′	57° 47′	12° 53′	48° 9′	6° 5′	35° 0′	2° 26′	21° 51′	0° 49′
120	57° 9′	33° 2′	49° 6′	11° 12′	40° 54′	5° 17′	30° 0′	2° 7′	19° 6′	0° 43′
130	47° 30′	27° 21′	40° 38′	9° 25′	33° 50′	4° 27′	25° 0′	1° 47′	16° 10′	0° 36′
140	37° 55′	21° 43′	32° 19′	7° 36′	26° 55′	3° 35′	20° 0′	1° 26′	13° 5′	0° 30′
150	28° 23′	16° 16′	24° 4′	5° 43′	20° 6′	2° 43′	15° 0′	1° 5′	9° 54′	0° 23′
160	18° 54′	10° 49′	15° 59′	3° 49′	13° 22′	1° 41′	10° 0′	0° 44′	6° 38′	0° 15′
170	9° 26′	5° 26′	7° 59′	1° 54′	6° 40′	0° 55′	5° 0′	0° 22′	3° 20′	0° 7′
180	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′

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[Margin: Ratio Calculi.] *The method of the calculation.*

Here is how we carried out the calculation. Let S (in the next diagram, A) be the Sun, T the Earth, C the head of the comet, C D the tail, D its extremity, S T the interval of the Sun, and C T the interval of the comet, for example half the Sun's. Now in the oblique-angled triangle S C T, from the intervals S T and C T and the included angle S T C, namely the given distance of the comet from the Sun, let the angle S C T at the comet be sought. 2. In the oblique-angled triangle T C D, from the angle D C T, namely the supplement to 180 degrees of the angle S C T just found, and from the given true length of

575 On the page the table is boxed, its caption standing inside the frame. Six column-groups are headed in roman: the first, Interval from the Earth, stands over the single column of distances, sub-headed Distance of the comet from the Sun and unit Degrees; each of the other five names an interval of the comet from the Earth and stands over two columns, Angle at the comet S C T and Apparent length of the tail, each in degrees and minutes (Gr. M.), printed as two figures. Here each degree-and-minute pair is set as one value, and the group head is repeated in the column head, its second column marked Same. Horizontal rules on the page divide the rows into groups of three; the first column is closed by a double rule and the groups are divided by double rules.

the tail C D, together with the interval of the comet from the Earth C T, let the angle C T D be found, which is the apparent length of the tail sought, by logarithms, in our usual way. By this method the whole table was constructed.

[Margin: Exemplum Calculi.] *An example of the calculation.*

For better understanding, however, I shall add one example: given an interval of the comet from the Earth of half the Sun's, and a length of the tail of 400 semidiameters of the Earth, at a distance from the Sun of 10 degrees.

The first *Logarith. Indic.*, in the triangle S C T [Logarith. Indic. prior in triangulo S C T.]

5063 *semidiameters of the Earth, S T* · 2532 *semidiameters of the Earth, C T*
2532 *C T* · 400 *C D*
2531 *difference, Log.* 137397 · 2132 *difference, Log.* 154552
7594 *sum, Log.* 27522 *S.* · 2932 *sum, Log.* 122689 *S.*
Log. Indic., the first: 109875 · *Log. Indic.* 31863
85° 0′ *half the complement of the angle S T C* · *mesologarithm* — 243625
Log. Indic. · + 109875 *A.*
75° 17′ *angle of difference* · *mesologarithm* — 133750
160° 17′ *S C T, the angle sought at the comet*
80° 9′ *half* · *mesologarithm* — 175084
Logarith. Indic. + 31863 *A.*
76° 34′ *angle of difference* · *mesologarithm* — 143221
3° 35′ *C T D, the apparent length of the tail sought*[576]

[Margin: Immutatis longitudine verâ, & diſtantiâCometæ à Terrâ, cauda apparens mirificè variatur : prout ex ſubjectâ elucet tabellâ.] *When the true length and the distance of the comet from the Earth are changed, the apparent tail varies remarkably, as is clear from the table below.*

It is therefore clear from the preceding table that, in all those intervals of the comet from the Earth that were supposed, and with a true length of the tail of 400 semidiameters of the Earth, the longest tail is never seen farther from the Sun than at the sixtieth degree. When, however, the interval of the comet from the Earth is diminished, and likewise the true length of the tail, the longest apparent tail comes much nearer to the quadrant, as we pointed out on the preceding page. But so that the more eager investigator of these matters may not miss this either, namely how great the apparent tail is at those smaller intervals, 50, 100, 200, 300, 400 and 500 semidiameters of the Earth, given a true length of the tail of 3 degrees up to 30, and indeed at every third degree, and also at what digression from the Sun the longest tail is seen, I have gladly committed these too to calculation and entered them in a table. From

[576] The calculation is printed in columns: on each line the parts separated here by a raised point stand side by side on the page, the left part working the triangle S C T and the right parts the triangle T C D and the mesologarithms. Rules under the figures that are added or subtracted are not reproduced. The dashes before the mesologarithms and the plus signs before 109875 and 31863 are printed. Line 7 prints degree and minute marks; the other angles print bare figures, set here as degrees and minutes.

it you will see that the tail varies in different ways, and that sometimes it first appears at its longest at a digression from the Sun of 70 degrees, 80, and even 87 degrees.

Table showing the greatest apparent lengths of various comet tails, together with the distance of the comet from the Sun required [for them], for various intervals of the comet from the Earth, supposing the interval of the Sun from the Earth to be 5100 semidiameters of the Earth.

Interval of the comet from the Earth: true length of the tail (semidiameters of the Earth)	50 semidiameters of the Earth: apparent length of the tail	Same: distance of the comet from the Sun	100 semidiameters of the Earth: apparent length of the tail	Same: distance of the comet from the Sun	200 semidiameters of the Earth: apparent length of the tail	Same: distance of the comet from the Sun	300 semidiameters of the Earth: apparent length of the tail	Same: distance of the comet from the Sun	400 semidiameters of the Earth: apparent length of the tail	Same: distance of the comet from the Sun	500 semidiameters of the Earth: apparent length of the tail	Same: distance of the comet from the Sun
3	3° 26′	86° 0′	1° 43′	87° 10′	0° 51′	86° 54′	0° 34′	86° 4′	0° 26′	85° 4′	0° 20′	84° 2′
6	6° 54′	82° 32′	3° 26′	85° 27′	1° 43′	86° 2′	1° 9′	85° 29′	0° 51′	84° 39′	0° 41′	83° 41′
9	10° 22′	79° 4′	5° 10′	83° 43′	2° 34′	85° 11′	1° 43′	84° 55′	1° 17′	84° 23′	1° 2′	83° 20′
12	13° 53′	75° 34′	6° 54′	82° 0′	3° 26′	84° 20′	2° 18′	84° 20′	1° 43′	83° 47′	1° 23′	82° 59′
15	17° 27′	72° 0′	8° 38′	80° 16′	4° 18′	83° 28′	2° 52′	83° 46′	2° 9′	83° 21′	1° 43′	82° 39′
18	21° 6′	68° 22′	10° 22′	78° 32′	5° 10′	82° 36′	3° 26′	83° 12′	2° 35′	82° 55′	2° 4′	82° 18′
21	24° 50′	64° 39′	12° 7′	76° 48′	6° 2′	81° 44′	4° 1′	82° 37′	3° 1′	82° 29′	2° 24′	81° 58′
24	28° 41′	60° 50′	13° 53′	75° 2′	6° 54′	80° 52′	4° 35′	82° 3′	3° 26′	82° 4′	2° 45′	81° 37′
30	36° 52′	52° 41′	17° 27′	71° 28′	8° 38′	79° 9′	5° 44′	80° 54′	4° 18′	81° 12′	3° 26′	80° 56′

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Finally, let us return to the comet of the year 1652, and, just as for each day of its appearance, from the longitude and latitude, the interval of the comet from the Earth, and also from the apparent length of the tail, we investigated the angle at the comet and at the same time the true length of the tail, both in semidiameters of the Earth and in German miles, so let us likewise now go and examine whether the apparent length of the tail too, on each of the days on which it was observed, consistently appeared as great as it really was, or as it could at some time have appeared at some definite distance of the comet from the Sun. We shall find, moreover, in every observation, that the comet could have displayed a far longer coma if it had had an entirely different distance from

[577] On the page the table is boxed with its caption inside the frame. The first column is headed Interval of the comet from the Earth over the sub-head True length of the tail, unit Sem.T.; each of the six groups that follow is headed by an interval of the comet from the Earth and stands over two columns, Apparent length of the tail and Distance of the comet from the Sun (printed à ☉), each in degrees and minutes (Gr.M.), printed as two figures. Here each pair is set as one value, and the group head is repeated in the column head, its second column marked Same. Horizontal rules divide the rows into groups of three. The first column prints no row for 27.

the Sun. Since this will without any doubt be not unwelcome for some to learn, let us therefore work to make plain from calculation how great a difference there was between the apparent length of the tail as observed and the length that could have been seen at some definite, fixed digression from the Sun. In this way it will become more and more evident that everything we derived in the preceding pages and tables holds good: namely, the manner in which the variation of the apparent tail arises from the varying position of the comet relative to the Sun — above all when comets, as in the example of this one of the year 1652, take up a different distance from day to day and climb higher, and their tails also actually grow at one time and shrink at another, and are very inconstant.

[Margin: An apparens longitudo caudæ Com. 1652, tanta ſemper apparuerit, quanta rever[[à/á]] extitit ?] *Whether the apparent length of the tail of the comet of 1652 always appeared as great as it really was?*

[Margin: Methodus Calculi.] *Method of the calculation.*

This calculation is carried out with the help of the latter diagram, B, which corresponds closely to the former one, A, set beside it, except that here the angle D, at the end of the tail, is a right angle in every case. This is so because, according to the theorem given on p. 527, the tail always appears greatest when it forms a right angle with the line of sight directed to its end.

Diagram. The left-hand diagram of an engraved block of two, lettered A. A semicircle stands on a horizontal base, with its centre at T. S lies at the far left end of the base, outside the semicircle. Two straight lines run from S; each meets the arc at a point C and runs on to a point D. Lines join T to each C and to each D. Below the diagram, at the lower left of the block, is the engraver's signature.

- A (upper left): the diagram's letter
- D (upper left, above the left-hand C): end of a line from S
- C (on the arc, left): point where a line from S meets the arc
- C (on the arc, right): point where the second line from S meets the arc
- D (upper right, beyond the arc): end of the second line from S
- S (left end of the base): the Sun's point
- T (centre of the base, below): the centre of the semicircle
- Autor ſculpsit. (script, lower left): Engraved by the author

Diagram. The right-hand diagram of the same engraved block, lettered B. A long base line runs from S at the lower left to T at the lower right. A line from S rises to the comet's head, drawn as a hatched disc at C, and the tail is drawn from C to D. A straight line labelled *Orbita* passes obliquely through C; a line from D falls toward the base; an arc rises from C over the tail, and a further curved line descends to T.

- B (upper left): the diagram's letter
- C (left of the hatched disc): the comet's head
- D (above the tip of the tail): the end of the tail

- Orbita. (script, along the oblique line through C, reading downward): Orbit
- S (lower left end of the base): the Sun
- T (lower right, below the base): the Earth

Therefore the right-angled triangle C D T must be solved first, to obtain the longest tail that could have been seen anywhere. This is found by means of C D, namely the true length of the tail in semidiameters of the Earth, and C T, the interval of the comet from the Earth. From these two sides let the angle C T D be sought, the greatest apparent length of the coma; its complement to a right angle gives the angle D C T. Next, for the required distance of the comet from the Sun, namely the angle S T C, let the oblique-angled triangle C S T be solved. Given C T, the interval of the comet from the Earth, and S T, that of the Sun from the Earth, the angle C S T at the Sun is found. If you subtract this from D C T, just found, there remains the angle sought, S T C, that is, the required distance of the comet from the Sun.

Calculation [CALCULUS.]

December 20 · December 27

How long the tail could have been seen at its longest · For the greatest appearance of the tail

27½ *semidiameters of the Earth*, C D, *Log.* 589380 · 29 *semidiameters of the Earth*, D C, *Log.* 584373

110, C T, *Log.* 450986 *S.* · 265, T C, *Log.* 363061 *S.*

14° 31′, C T D, *greatest length*, *Log.* 138394 · 6° 17′, C T D, *Log.* 221312

75° 29′, D C T · 83° 43′, D C T

For the required distance from the Sun, S T C · Required distance of the comet from the Sun, S T C

110 *semidiameters of the Earth*, C T, *Log.* 450986 · 265 *semidiameters of the Earth*, T C, *Log.* 363061

5063, S T, *Log.* 68062 *S.* · 5063, S T, *Log.* 68062 *S.*

difference 382,924 · *difference* 294,999

75° 29′, D C T, *Log.* 3245 *A.* · 83° 43′, D C T, *Log.* 602 *A.*

S. 1° 12′, C S T, *Log.* 386169 · *S.* 2° 59′, C S T, *Log.* 295601

74° 17′, S T C, the required distance · 80° 44′, S T C, the required distance

On December 23 · December 30

For the longest apparent tail · For the greatest appearance of the tail

21⅓ *semidiameters of the Earth*, C D, *Log.* 614925 · 20¼ *semidiameters of the Earth*, C D, *Log.* 620320

114, C T, *Log.* 447414 *S.* · 817, C T, *Log.* 250470 *S.*

10° 48′, C T D, *greatest length*, *Log.* 167511 · 1° 25′, C T D, *Log.* 369850

79° 12′, D C T · 88° 35′, D C T

For the required distance from the Sun, S T C · Required distance of the comet from the Sun, S T C

114 *semidiameters of the Earth*, C T, *Log* 447414 · 817 *semidiameters of the Earth*, C T, *Log.* 250470

5063, S T, *Log.* 68062 *S.* · 5063, S T, *Log.* 68062 *S.*
difference 379,352 · *difference* 182,408
79° 12′, D C T, *Log.* 1787 *A.* · 88° 35′, D C T, *Log.* 31 *A.*
S. 1° 16′, C S T, *Log.* 381139 · *S.* 9° 17′, C S T, *Log.* 182439
77° 56′, S T C, the required distance · 79° 18′, S T C, the required distance
December 25 · January 3
For the greatest apparent tail · For the greatest appearance of the tail
6⅖ *semidiameters of the Earth*, C D, *Log.* 735442 · 180 *semidiameters of the Earth*, C D, *Log.* 401939
146, C T, *Log.* 422673 *S.* · 3000, C T, *Log.* 120397 *S.*
2° 31′, C T D, *Log.* 312769 · 3° 26′, C T D, *Log.* 281542
87° 29′, D C T · 86° 34′, D C T
For the required distance from the Sun, S T C · Required distance of the comet from the Sun, S T C
146 *semidiameters of the Earth*, C T, *Log.* 422673 · 3000 *semidiameters of the Earth*, C T, *Log.* 120397
5063, S T, *Log.* 68062 *S.* · 5063, S T, *Log.* 68062 *S.*
difference 354,611 · *difference* 52,335
87° 29′, D C T, *Log.* 97 *A.* · 86° 34′, D C T, *Log.* 180 *A.*
S. 1° 39′, C S T, *Log.* 354708 · *S.* 36° 16′, C S T, *Log.* 52515
85° 50′, S T C, required distance of the comet from the Sun · 50° 18′, S T C, the required distance
December 26 · January 4
For the greatest appearance of the tail · For the greatest apparent tail
10⅖ *semidiameters of the Earth*, C D, *Log.* 686825 · 192 *semidiameters of the Earth*, C D, *Log.* 395331
189, C T, *Log.* 396859 *S.* · 3957, C T, *Log.* 92709 *S.*
3° 9′, C T D, *Log.* 289966 · 2° 47′, C T D, *Log.* 302622
86° 51′, D C T · 87° 13′, D C T
For the required distance from the Sun, S T C · Required distance of the comet from the Sun, S T C
189 *semidiameters of the Earth*, C T, *Log.* 396859 · 3957 *semidiameters of the Earth*, C T, *Log.* 92709
5063, S T, *Log.* 68062 *S.* · 5063, S T, *Log.* 68062 *S.*
difference 328,797 · *difference* 24,647
86° 51′, D C T, *Log.* 151 *A.* · 87° 13′, D C T, *Log.* 118 *A.*
S. 2° 8′, C S T, *Log.* 328948 · *S.* 51° 19′, C S T, *Log.* 24765

84° 43′, S T C, required distance of the comet from the Sun · 35° 54′, S T C, the required distance[578]

[Margin: Omnes variationes hujus Cometæ,tum quo ſitu cauda ejus videri potuiſſet longiſſima,Autor in tabellam retulit.] *The author has entered in a table all the variations of this comet, and also the position in which its tail could have been seen at its longest.*

To make everything still clearer, let us once again bring together in a table of its own whatever we have obtained, not only by this calculation but also by some of the earlier ones: namely, 1. the true longitude of the Sun; 2. the true longitude and latitude of this comet of the year 1652, beginning from December 18 and running to January 4; 3. the interval of the comet from the Earth; 4. the apparent length of the tail; 5. the apparent distance of the comet from the Sun; 6. the angle at the comet between the Sun and the Earth; 7. the true length of the tail in semidiameters of the Earth; 8. the true length of the tail in German miles; 9. the interval of the end of the tail from the Earth; 10. how long, at its greatest, the tail could have been seen at so great an interval from the Earth; 11. the distance of the comet from the Sun required for the tail to be seen at its longest. With the help of this table you will by no means be left unaware of any variation of the comet from its first rising to its extinction, nor of the position relative to the Sun in which the tail could have been seen at its longest.

A table showing the true length of the tail of the comet seen in the year 1652 and 1653, the interval of the Sun at perigee from the Earth being supposed 5063 semidiameters; and also the position of the comet relative to the Sun in which the tail could have been seen at its longest [TABULA exhibens Longitudinem veram Caudæ Cometæ / Anno 1652 & 53 viſi, ſuppoſito intervallo Solis perigæi à Terrâ 5063 Semidiamet. / Itemq; : quo ſitu Cometæ ad Solem cauda potuiſſet videri longiſſima.]

[578] The calculation is printed in two columns, each holding four days worked in turn: on the left December 20, 23, 25 and 26, on the right December 27, 30, January 3 and 4. On each line the part before the raised point stands in the left column and the part after it in the right column, side by side on the page. In each day's block the figures stand at the left, the triangle letters in the middle and the logarithms at the right. Rules under the subtracted and added logarithms and under the subtracted angles are not reproduced. Many angles print bare figures, or a degree mark with no minute mark; they are set here as degrees and minutes. The Sun is printed with its sign in several of the subheadings. The December 27 block prints D C and T C where the other blocks print C D and C T. No year is printed with the dates.

	True longitude of the Sun (deg., min.)	True longitude of the comet (deg., min.)	Latitude of the comet (deg., min.)	Interval of the comet from the Earth, T C (semidiam. of the Earth)	Apparent length of the tail, D T (deg., min.)	Apparent distance of the comet from the Sun, S T C (deg., min.)	Angle at the comet between the Sun and the Earth, S C T (deg., min.)	True length of the tail, C D, in semidiam. of the Earth	True length of the tail, G. D, in miles	Interval of the end of the tail from the Earth, T D (semidiam. of the Earth)	Greatest length at which the tail could have been seen at so great an interval from the Earth (deg., min.)	Distance of the comet from the Sun required for the tail to be seen at its longest (deg., min.)
December 18	27° 37′ ♐	8° 0′ ♊	31° 0′ *A.*	114	1° 30′	128° 21′	50° 40′	4	3440	117	1° 59′	86° 44′
19	28° 38′	13° 10′	41° 0′	110	2° 0′	136° 37′	42° 33′	6	5160	114	3° 5′	85° 40′
20	29° 39′	8° 24′	30° 49′	110	7° 0′	143° 10′	36° 6′	27½	23700	133	14° 31′	74° 17′
23	2° 43′ ♑	9° 24′	32′	114	5° 0′	146° 34′	32° 44′	21⅓	18360	132	10° 48′	77° 56′
December 25	4° 45′ ♑	2′ ♉	41′ *B.*	146	1° 30′	140° 48′	38° 11′	6⅖	5502	151	2° 31′	85° 50′
26	5° 47′	24° 42′	13° 4′	189	2° 0′	137° 15′	41° 21′	10⅖	8946	197	3° 9′	84° 43′
27	6° 48′	23° 35′	16° 36′	265	4° 0′	134° 18′	43° 38′	29	24920	287	6° 17′	80° 44′
30	9° 52′	21° 28′	23° 25′	817	1° 0′	127° 32′	45° 49′	20¼	17400	831	1° 25′	79° 18′
January 3	13° 57′ ♑	4′ ♉	8° 42′ *B*	3000	2° 0′	121° 8′	37° 39′	180	154500	3144	3° 26′	50° 18′
4	14° 59′	19° 52′	29° 40′	3957	1° 30′	119° 48′	34° 10′	192	165000	4117	2° 47′	35° 54′

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[Margin: Cauda Cometæ 1652 nunquam tantæ longitudinis apparuit, quantæ reverà extitit.] *The tail of the comet of 1652 never appeared as long as it really was.*

It is therefore abundantly clear that on no day whatever did the tail appear as great in length as it really was. For all the apparent lengths of the tail observed on each day were far smaller than those, derived by calculation, that could have been seen, provided only that the elongation of the comet from the Sun had at that time been well below 90 degrees, as the table shows. For example, on December 20, the first day of its shining, the tail was seen here by us at Danzig to be 7 degrees long; but it would have been seen 14° 31′ long if it had stood

579 On the page the table is boxed, with its caption inside the frame. The first column has no head; it carries the day numbers, and the month is printed sideways once for each group of rows (December, December, January). Every angle is printed as two figures, degrees and minutes, under the unit heads Gr.M. or Gr.Min.; here each pair is set as one value. The zodiac signs stand after the figures only where printed, at the first row of a group or where the sign changes. The letters A. and B. after the latitudes are printed unexpanded (the row for January 3 prints B with no point). Horizontal rules divide the rows into three groups, as here.

only 74° 14′ from the Sun. Since, however, it was 143° 10′ away from the Sun, for that reason it could not be seen longer than 7 degrees. The phenomenon behaved in nearly the same way on the following days too, though sometimes in a different proportion: not always as one to two, but at times even as one to three.

[Margin: Vix unquam caudas tantæ proceritatis apparere, quantæ reverà ſint.] *Tails hardly ever appear as long as they really are.*

I therefore hold that it must be firmly laid down (and no comet will ever contradict this view either) that tails of as great a length very rarely are seen as they really are. Indeed, they often not only appear extremely short but even escape all sight of the eyes entirely, although in reality they are as long as can be. This is clear from the figure and calculation on pages 524 and 525 mentioned earlier, and above all the comet of the year 1652 confirms it. For on January 4, when the coma shone over only 1° 30′, while at the same time its greatest length could not be seen beyond 2° 47′ at a distance of the comet from the Sun of 35° 54′, the true length of the comet was nevertheless then given as 192 semidiameters of the Earth.

[Margin: Superiora phænomena ita penitùs ſe ſe habere omnia, aliis quibusdam Cometis demonſtratur.] *It is shown from certain other comets that all the phenomena above are entirely as stated.*

But so that no ground for hesitation whatever may stay fixed in anyone's mind, it will not be difficult to demonstrate the very thing we have properly derived from the comet of the year 1652 from four other, different comets as well, those of 1577, 1590, 1607 and 1618, by calculation no less exact; and likewise, following the earlier method, to construct a table from the data and the quantities sought. This table will display not only the distance of the comet from the Sun, the angle at the comet, and their true length in semidiameters and in miles, but will also show that the true length of some comets far exceeded even the size of the tail of the comet of the year 1652, although around its last appearance that tail equalled 192 semidiameters of the Earth. For the comet of the year 1590, on February 23, had a tail of 252½ semidiameters of the Earth. The comet of the year 1618, on December 10, its apparent [tail] being given as 104° according to Longom. [Longomontanus], had grown to 438 semidiameters of the Earth. Not to mention that if we consider the comet of 1607 at its greatest distance from the Earth, then, although its apparent tail is given as only 10°, the true length of the tail was nevertheless no less than 1301 semidiameters of the Earth. And this tail was the greatest of all in length, at least as far as has been handed down to memory from antiquity. Meanwhile, however, it is not so absurd that others too may once have shone, far surpassing this one in the length of their tail; but since examples are entirely lacking, we must rest wholly content with the greatest length just mentioned, 1301 semidiameters of the Earth.

[Margin: Vera longitudo caudæ, Cometæ 1607 fuit aliarum omnium maxima.] *The true length of the tail of the comet of 1607 was the greatest of all the others.*

[Margin: Quænam, ſubſequentis Tabellæ beneficio, innoteſcant.] *What becomes known with the help of the following table.*

Moreover, a great many other things of this kind, most worth noting, are revealed with the help of this table for saving any appearances of tails whatever: namely, how long, at its longest, the coma of these comets could have been seen, and at what distance from the Sun; and also how great an angle at the comet is required for seeing it at that length. Furthermore, it is most certain that the tails of comets not infrequently appear much shorter than they could be seen in a certain position, or than they really are. This is most evident in the comet of the year 1618: although its tail at all times displayed an astonishing length, beyond all others, it was nevertheless never perceived at that time to be as great as it could have appeared to the eyes.

[Margin: Quo ſitu cauda Cometæ 1618 videri potuiſſet 180 grad.] *In what position the tail of the comet of 1618 could have been seen at 180 degrees.*

For although on December 9 the tail was noticed by Cysat to be only 75°, near the Sun, if only it could have come into view, it would have appeared 180°. It showed nearly the same aspect on December 10, 17 and 19 as well, when it was observed at scarcely more than 50 degrees. And so, around the very conjunction with the Sun, where the angle at the Sun vanishes entirely, it would have been seen longer than 146 degrees, as is entirely plain from this table and from the figure inserted on page 525.

[Margin: Poſſunt quandoq; Cometarum caudæ tantæ longitudinis apparere quantæ reapſe exiſtunt.] *The tails of comets can sometimes appear as long as they actually are.*

I readily grant, however, that the apparent tail observed can sometimes be of the same length as the one it could ever present anywhere: as in the example of the comet of the year 1577, whose tail on November 13 was found to shine over 25 degrees, which could have been displayed as no more than 26° 54′ at any elongation whatever from the Sun. Likewise, observers measured the tails of the comets of the year 1590, on February 23, and of the year 1607 at 10 degrees: scarcely a few minutes below the length that, even at its greatest, ever happens to be seen.

Month and day	Longitude of the comet (deg., min.)	Northern latitude of the comet (deg., min.)	Interval of the comet from the Earth, C T (semidiameters of the Earth)	Apparent length of the tail (deg., min.)	Distance of the comet from the Sun, S T C (deg., min.)	Angle at the comet, S C T (deg., min.)	True length of the tail (semidiameters of the Earth)	True length of the tail (miles)	Interval of the tail from the Earth, T D (semidiameters of the Earth)	Greatest length at which it could have been seen (deg., min.)	Required distance of the comet from the Sun (deg., min.)	Required angle at the comet, S C T (deg., min.)
Year 1577. From the observation of Tycho, and on his solar hypothesis.												
November 13, Old Style	7° 7′ ♏	38° 53′	210	25° 0′	39° 22′		95	81700		26° 54′	51° 27′	116° 54′
Year 1590. From the observation of Tycho, and on his solar hypothesis.												
February 23, Old Style	18° 27′ ♓	18° 14′	1200	10° 0′	37° 26′	65° 37′	252½	217100	1324	10° 21′	20° 46′	69° 14′
Year 1607. From the observation of Kepler, and on his solar hypothesis.												
September 16, Old Style	18° 30′ ♍	30° 30′	449	10° 0′	54° 36′	118° 46′	82½	70890	416	10° 35′	71° 59′	100° 35′

Month and day	Longitude of the comet (deg., min.)	Northern latitude of the comet (deg., min.)	Interval of the comet from the Earth, C T (semidiameters of the Earth)	Apparent length of the tail (deg., min.)	Distance of the comet from the Sun, S T C (deg., min.)	Angle at the comet, S C T (deg., min.)	True length of the tail (semidiameters of the Earth)	True length of the tail (miles)	Interval of the tail from the Earth, T D (semidiameters of the Earth)	Greatest length at which it could have been seen (deg., min.)	Required distance of the comet from the Sun (deg., min.)	Required angle at the comet, S C T (deg., min.)
October 10	2° 0′ ♐	12° 0′	4588	10° 0′	37° 4′	47° 45′	1301	1119000	3547	10° 3′	42° 0′	48° 0′
Year 1618. From the observation of Cysat, but on Kepler's hypothesis of the Sun.												
December 1	9° 22′ ♏	50′	72	22°	35° 0′	144° 17′	32	27440	50	26° 18′	62° 36′	116° 18′
7	29° 23′ ♎	37′	90	57°	44° 20′	134° 34′	77	66470	66	59° 11′	30° 2′	149° 11′
8	28° 21′ ♎	47′	93	58°	51° 42′	127° 2′	84½	72630	80	65° 16′	23° 44′	155° 16′
December 9	26° 18′ ♏	29′	96	75°	57° 48′	120° 47′	29½	111300	115	180° 0′	0° 0′	0° 0′
10	23° 37′ ♏	4′	100	104°	61° 40′	116° 48′	438	376600	399	180° 0′	0° 0′	0° 0′
17	8° 49′ ♑	20′	132	56°	81° 13′	96° 33′	170	146200	202	180° 0′	0° 0′	0° 0′
December 18	6° 20′ ♑	2′	142	54°	84° 0′	93° 35′	180	155050	222	180° 0′	0° 0′	0° 0′
20			162	34°	89° 53′	87° 22′	113	97080	202	44° 10′	43° 50′	134° 10′
21	28° 23′ ♒	20′	172	21°	90° 34′	86° 30′	68	58250	157	23° 12′	64° 6′	113° 12′
December 28	8° 31′ ♍	57′	242	35°	103° 10′	72° 52′	226	194500	377	69° 8′	19° 24′	159° 8′
29	6° 6′ ♍	28′	252	35°	104° 12′	71° 42′	242	208000	400	73° 41′	15° 6′	163° 41′
January 7	11° 38′ ♌	28′	400	8°	115° 49′	58° 20′	72	62190	442	10° 25′	72° 50′	100° 25′

[580] On the page the table is boxed and runs across the full width of the leaf, into the side-note column, between the first paragraph and the second. Thirteen ruled columns, headed in italic; the units stand in a ruled row beneath the heads (degrees and minutes; semidiameters of the Earth; miles). Each comet has a full-width caption row, set here in bold. Old Style is printed as a second line of the date cell for 1577, 1590 and September 16, 1607. In 1618 the apparent length of the tail is printed in whole degrees only. Blank cells are blank on the page: for 1577 the angle at the comet and the interval of the tail from the Earth; for December 20 the longitude and latitude. The third head prints Latitado for Latitudo.

Since, therefore, it is placed beyond all hazard of doubt that very many tails of comets appear at various times shorter in appearance than [they would] in some other place in the heavens, a pleasing speculation has also come into our mind: namely, that when the tails are compressed as to sight, the heads are seen to shine in front of the tail, and indeed within the tail itself. Hence, given a more compressed tail, the head (insofar as the tail is wider in the middle than at its issue and at its end) is enlarged to some extent, or is seen as larger. For it is surrounded, as it were, by the rays of the tail and by a dark little cloud. Moreover, the tail then mostly looks pyramidal, on this express condition, namely, that the tail be wider in the middle and pointed at the end; otherwise this phenomenon follows the shape of the coma.

[Margin: Datâ compreſſiore caudâ,caput quadantenus augetur, ſed apparenter.] *Given a more compressed tail, the head is enlarged to some extent, but in appearance.*

But let me set out our view more clearly. In the following Figure R, let S be the Sun, T the Earth, C the comet. When the comet is situated below the Sun in sextile aspect, as at A, a comet whose tail is like the one drawn, broader, namely, in the middle than the head, and at the same time pointed at the end, then, I say, it shines with its genuine length and appearance, as was shown at length above. But when it gradually moves away from the Sun, whether

[Margin: Demonſtratur, quomodo fieri poſſit,ut Cometa denſiſſimâ quaſi nube circundatus, atq̃; ſimul pyramidatus appareat.] *It is shown how it can happen that a comet appears surrounded as if by a very dense cloud, and at the same time pyramidal.*

it is thereby higher or lower, the angle of vision D T C decreases, and the tail is compressed. And since at B, F and H the tail is wider in the middle than the head itself, the same head must certainly be seen as if under the tail, as though it were situated in front of the tail, or rather within the tail itself. Indeed, if the angle D T C is given smaller by half, as at A, the head appears in the middle of the tail, that is, in its more extended part. As a result the coma then becomes not only shorter but also blunter, and moreover looser next to the head, than when it shines with its whole and unimpaired appearance. Indeed, the head is enlarged not a little, by reason of the breadth of the tail; and it presents the appearance of being surrounded by a very dense cloud, and the tail then, for the most part, as pyramidal. The reason for this is clear from the accompanying figure. In it we have at the same time sketched, for a given more acute angle, as at B, F and H, in which part of the tail the head would then be seen, namely at *e*, *f* and *h*; and in the same place we have likewise drawn in what appearance the comet would then appear, as at E, G and I.

[Margin: Quando extremitas caudæ capite ſit vicinior; quâ facie Cometa tum appareat.] *When the end of the tail is nearer than the head; in what appearance the comet then appears.*

But when the end of the tail is not elongated by so great an interval as the head itself, as at L, the compression of the tail takes on an entirely different

appearance. For there the part of the tail adjacent to the head is not drawn together so much as the parts at the far end, at D, then are; and so the end of the tail is narrowed and compressed in proportion to the diminished angle of vision, and then the tail always looks denser and, likewise, blunter.

Something similar also happened with the comet of the year 1652. For it was found that it had a head of immense size, and a tail likewise entirely equal to the head itself at its issue, but pointed at its end, like a pyramid or cone. Next, we have also established by calculation, as the table above on page 529 attests, that the tail of that comet appeared much shorter in every observation than if it had been nearer the Sun. Hence the tail had to compress itself in a similar way, and the head to present itself in front of the tail, or rather as if within the tail. It is also consistent that, since the head displayed a singular size, the tail was certainly not a little wider in the middle than below the head (provided that it had been seen at its greatest, at its true length and angle of vision). It follows, therefore, since the former is most true, that the latter is also likely: that the head showed itself to us somewhat larger than it should have, than in the place where it would have shone with its tail at its greatest; and that the tail also displayed an equal breadth next to the head, but was pointed at the end.

[Margin: Asſertiones præcedentes, Cometâ 1652 clarisſimè probantur.] *The preceding assertions are proved most clearly by the comet of 1652.*

[Margin: Caput hujus Cometæ ſub caudâ viſum esſe.] *That the head of this comet was seen under the tail.*

But let us set out all this graphically and more clearly. On December 20 the comet shone with a very large head, as can be seen at P in the figure shown; and the tail was very broad near the head and pyramidal at its end, 7 degrees in length. But if it had been 74° 17′ distant from the Sun, the tail would have been twice as long, namely 14° 31′. Therefore it could not have happened otherwise than that, with [the tail] shorter and more compressed in appearance, the head then appeared in the very middle of the tail, as is seen at P in the same place. Therefore, with the coma in reality 14° 13′ at the greatest angle of vision C D, the head would without doubt have appeared partly smaller, and the tail wider in the middle. For it is most in keeping with reason that all comets generally show tails wider in the middle than below the head; and indeed for this reason, that the solar rays, by means of refraction and of varied reflection, are rather scattered and drawn apart, instead of being gathered and joined as they should be. That which

[Margin: Caput Cometæ 1652 in medio caudæ apparuisſe, atq́; exinde comam pyramidatam exhibuisſe,adhuc clariùs demonſtratur.] *It is shown still more clearly that the head of the comet of 1652 appeared in the middle of the tail, and consequently displayed a pyramidal coma.*

[Margin: Quare Cometarum Syrma in medio pleruną; ſit amplius ?] *Why the train of comets is generally wider in the middle.*

Diagram. Full-page engraved plate, Figure R, the figure cited on p. 617 (in the following Figure R) and p. 618 (the accompanying figure; the figure shown,

at P). It has two parts. In the upper part a semicircle stands on a horizontal base line, with the Sun (S, a rayed disc at the left end of the base) and the Earth (T, a small circle at the centre of the base). Three concentric arcs are drawn about T, and straight lines run from T and from S to the comets. Comets with tails stand at various places on and between the arcs. Three show a second, inner head drawn within the tail (the comets at F and H, and the comet c–d at the lower right); the italic e, f and h stand beside the tails of the comets at B, F and H; and each ruled tail tip is marked d. In the lower part six comet drawings are set one below another: four dated drawings (20 December, 23, 26, 27), each with a capital above its middle head, c at its left head and d at the tip of its tail, then two undated drawings, T (a second head at the left, unlabelled) and V (a single head with a broad fan-shaped tail). Engraved legends: Fig. R. at the lower left, and Autor fculpsit [Engraved by the author] at the lower right.

- G (upper part, top centre): a comet; no lowercase letter
- d (top right): tip of the tail of the comet at F, at the end of a line from T
- *f* (top right): beside the inner head drawn within that tail
- d (upper left, outer arc): tip of the tail of the comet at B
- c, F (outer arc, upper right): comet head
- E (upper left): a comet; no lowercase letter
- I (right of centre): a comet; no lowercase letter
- *e* (upper left): beside the tail of the comet at B
- B, c (middle arc, left): comet head
- *h* (right): on the line to the tip of the tail of the comet at H
- d (right): tip of the tail of the comet at H
- c, H (inner arc, right): comet head
- d (inner arc, left): tip of the tail of the comet at A
- A, c (left, between the inner arc and S): comet head
- d (lower left of centre): tip of the tail of the comet at L
- c, d (lower right, inner arc): a comet head and its tail tip; no capital
- M (lower left): a comet; no lowercase letter
- c, L (on the base line, right of S): comet head
- S (left end of the base line): the Sun
- T (centre of the base line): the Earth
- a comet on the middle arc at the right, above the comet c–d: no letter
- 20 Decembr. [20 December], P, c, d (first lower drawing)
- 23., Q, c, d (second lower drawing)
- 26., R, c, d (third lower drawing)
- 27., S, c, d (fourth lower drawing)
- T (fifth lower drawing)
- V (sixth lower drawing)
- Fig. R. (lower left)

• Autor ſculpsit [Engraved by the author] (lower right)[581] very many comets, it is easy to demonstrate, since under the greatest angle of vision they presented themselves at all times with the said appearance: for example, the comet of the year 1577, [that of] 1590 and [that of] 1647, and likewise [that] of the year 1618, namely at the beginning of December, and others, which I gladly omit to list here. That they are, however, generally pointed comes from the fact that the rather numerous lateral rays vanish sooner than the central ones, which are poured out in greater abundance and are, as it were, more tightly combined.

So, most eager reader, you have at P the comet of 1652: with what appearance it was observed on December 20 under a smaller angle, because of its excessive distance from the Sun; then in what form it would have appeared under the greatest angle of vision; and moreover why it was seen with a somewhat larger head and a pointed tail, but wider at the head — which was to be shown. But with what appearance the said comet shone on December 23, 26 and 27, and with how much longer a tail, at a certain distance from the Sun under the greatest angle of vision, we have likewise drawn accurately at Q, R and S, with the help of the little table added on page 533.

[Margin: Vnde Cometa 1652,facie adeò diversâ luxerit ?] *Why the comet of 1652 shone with so different an appearance.*

From these the following axioms now seem to flow. 1. Generally, when the tails of comets appear pyramidal and at their issue show a breadth equal to the head, the comets are no longer seen under the greatest angle of vision, where [they would] otherwise [be seen] with a very long tail, but under some smaller, or more acute, angle, where they are seen with a more compressed and, as it were, curtailed coma.

[Margin: Axiomata; Pro caudis Cometicis.] *Axioms for the tails of comets.*

[Margin: Caudæ in conum faſtigiatæ ferè nunquam ſub maximo viſionis angulo conſpiciuntur.] *Tails tapered into a cone are almost never seen under the greatest angle of vision.*

2. The heads of comets appear somewhat larger when the tails are wider in the middle and the heads, because of the more oblique angle of vision, are carried there.

[Margin: Quorum caudæ in medio ampliores ſunt, eorum capita jurè majora videntur.] *Comets whose tails are wider in the middle rightly have heads that look larger.*

3. When a comet is beyond a quadrant from the Sun, or higher than that, the tail is never seen in its genuine appearance, that is, in a form more compressed below the head, but always as pyramidal from the head to the apex; and it is seen as the more acute or the more blunt according to the

[581] Every label on the plate was read; none is left unread. The text of pp. 617–618 names the comet as C and the tail tip as D (angle D T C; at D; C D), but the plate prints only lowercase c and d. The plate also carries letters the text of pp. 617–618 does not name: M, Q, R, S and T as labels of the lower drawings, V, and the four dates.

greater or smaller angle of vision. Unless perhaps (which certainly can sometimes happen) it actually shines with spread and diffused rays, as in drawing T of the earlier Figure K, shown on page 448; and then, under a more acute angle, and indeed one of half the size, the comet would appear at V with an entirely similar appearance: namely with its head set in the tail and somewhat larger, like a peacock's tail. A comet of this kind was noticed in the year of the Christian era 1401.

[Margin: Quando cauda compreſſiori facie ſpectetur.] *When the tail is seen with a more compressed appearance.*

[Margin: Quomodo coma Cometæ, inſtar caudæ Pavonis conſpici poſſit.] *How the coma of a comet can be seen like a peacock's tail.*

From this phenomenon, therefore, and from what has been said at length here and there — namely, in what way the head of a comet is often seen within the tail itself, nearer and nearer toward its end, according to the greater or smaller angle of vision — we understand, not wrongly, why the tail of the comet of the year 1618, more extended in the middle than next to the head and the end, was then seen to show a hump; and moreover why the hump clung closer to the head on one day than on another, as Cysat clearly found in that same comet. For he says, on page 64, Chapter IV *de Cometis*: *The hump* (or greatest breadth of the tail) *was today* (December 7) *farther from the head than recently* (December 1). And this came about because on December 7, as is clear from the table above, [section?] 4, the apparent length of the tail was of almost the same length as that which could have been seen as longest at a more remote distance from the Sun. On December 1, however, the tail could have been seen 4 degrees longer, namely at a greater distance from the Sun, as the same table attests; and therefore on this day the head stood nearer to the hump than on December 7. Not hid-

[Margin: Inſolitum phænomenum Cometæ 1618 rectè detegitur.] *An unusual phenomenon of the comet of 1618 is correctly uncovered.*

den from us any longer, therefore, will be the reasons for this unusual phenomenon: much less will it be necessary from now on to harp on this very thing as some occult quality, or to ascribe it to certain refractions and reflections existing in the head; but rather to state with confidence that this phenomenon arises entirely from the compression and dilation of the tail, or from the angle of vision.

[Margin: Hâc datâ hypotheſi plurima abſtruſa phænomena feliciter ſalvantur.] *Given this hypothesis, very many obscure phenomena are successfully saved.*

It remains to inquire what breadth even the widest tails of all comets enjoy in the middle. This question rests on observations that are quite sound. But since our predecessors, in this matter too, recorded almost nothing at all and handed nothing down to posterity, it is truly difficult to uncover the matter thoroughly. Yet as far as can be gathered from the comet of the year 1618 and from others, the tail around the hump extends, on the testimony of the most skilful Cysat, to 2, indeed 3 degrees. For, as is plain from Chapter IV of

the same Cysat, the breadth of the tail was: on December 7, 2° or 3°; on the 8th, 3; on the 9th, 2 and a little wider; on the 17th, 2, a little greater; on the 18th, 2, a little less. But by means of an extraordinary dilation, as we have also shown in its place, it spread itself out to a whole degree and more besides, if we believe Wendelen. We have not, however, found wider tails in the histories of comets; so it is not permitted to go further, but we shall have to stop here until something more certain can be drawn from the comets that follow, if any are generated and come forth into view.[582]

[Margin: Latitudo caudarum, omnium maxima quousq; ſe ſe extendat.] *How far the breadth of tails, the greatest of all, extends.*

Finally, it will also have to be investigated whether the end, or tip, of tails is sometimes farther from the Earth than the head itself, or rather nearer to it; and then at what time each is to be expected. As for the first, we have already understood here and there, not obscurely, that the distance of the end of the tail from the Earth cannot always be entirely equal, but that the end of the tail is found now much nearer to the Earth, now farther from it. The reason depends on this. First, as long as the comet is removed from the Earth by the same distance as the Sun, or is already carried above the Sun, so long is the tip of the tail always removed farther from the Earth than the head itself, at any digression from the Sun whatever. Second: when, however, the comet performs its motion below the Sun, the end of the tail can sometimes, at certain distances from the Sun, be less far from us than the head itself — and indeed according to these well-founded rules. 1. This never happens unless the comet stands within a quadrant from the Sun in the circle of distance. 2. When the angle at the comet's head and the one at the tip of the tail, at C and D, according to the diagram drawn on page 525, are found equal, the head and the tip are removed from the Earth by an exactly equal interval. 3. When, in turn, the comet is at the moment of conjunction with the Sun, where each of the said angles, at the head and at the tip, vanishes entirely, there the end of the tail is nearest to the Earth relative to the head; conversely, when the comet is in opposition to the Sun, the matter is entirely reversed. 4. But as it moves gradually away from the Sun, the more obtuse the angle at the end of the tail, the more acute that other angle at the comet; and the nearer, by so much, the tip of the tail is too. 5. Again, when the angle at the comet becomes more obtuse, and that at the end of the tail more acute, then the tip of the tail is removed farther from the Earth than the head itself:

[Margin: Quando extremitas caudæ remotior ſit ipſo capite.] *When the end of the tail is farther away than the head itself.*

[Margin: In quibusdam diſtantiis Cometâ infra Solem incedente, cuſpis caudæ vicinior eſt Terræ,ipſo capite.] *At certain distances, when the comet moves below the Sun, the tip of the tail is nearer to the Earth than the head itself.*

[582] On the page the five dates and breadths stand as a short list without rules, the days in one column and the breadths in another; only the first two figures carry a degree mark.

[Margin: Quo ſitu cuſpis caudæ & caput à Terrâ æquidiſtent.] *In what position the tip of the tail and the head are equidistant from the Earth.*

[Margin: Et ubi cuſpis caudæ Terræ ſit vicinisſima.] *And where the tip of the tail is nearest to the Earth.*

[Margin: Creſcente angulo ad Cometam; ad cuſpidem verò decreſcente,cuſpis magis magisq́; ipſo capite à ♁ removetur.] *As the angle at the comet grows and that at the tip decreases, the tip is removed from the Earth more and more than the head itself.*

or, what amounts to the same thing, the more the former angle grows and the latter decreases, the greater the interval at which the end of the tail, compared with the head, is removed from the Earth. Moreover, the tip at once begins to become more remote after the tail has already been seen at its longest. How all these things come about will be plain to you from the tables above and from the figure added on page 525, especially if you look into them somewhat more deeply; for all these things rest on the same foundation as what was said about the longest tail.

We therefore conclude that the ends of all tails vary greatly according to the greater or smaller interval from the Earth and the distance from the Sun, and also according to the true increase and decrease of the tail. Besides, since it is abundantly clear that in some comets the tip of the tail is nearer to the Earth than the head itself, it follows absolutely that in such configurations of comets — namely, with the tip nearer — even though the whole tail enjoys an equal breadth in every part, the tail always appears wider at the tip than below the head, because the tip is nearer than the head. Nearer things, however, are taken in under a greater angle, and therefore they also appear larger and more obtuse.

[Margin: Quando extrêmitas caudæ obtuſior appareat, quàm re ipsâ exiſtat.] *When the end of the tail appears more obtuse than it really is.*

2. But when the head comes nearer to the Earth than the tip itself does, then, even supposing that the tail itself displays an equal breadth, the tail is necessarily seen as more pointed at its end than in any other part, because the head is farther away and is seen under a smaller angle of vision; and the tip is then judged to be both narrower and more compressed and also paler and more diluted, because of that greater remoteness.

[Margin: Cauda latitudine ab omni parte reverà æqualis, quando pyramidata appareat.] *When a tail that is truly equal in breadth in every part appears pyramidal.*

3. From this we also infer, not wrongly, that the heads of those comets whose tail tips shine most brightly and glow with a more intense light, and which also show narrower tails below the head, are farther removed from us than their tips. But comets whose tails are more pointed and thinner around the end have heads nearer than their tips — on this condition, namely, that the whole tail is of the same breadth; otherwise this axiom would not be without its exception. But it is better that it still be left undecided, since it has not yet been sufficiently explored whether this is common to all comets, until exact observations, if any are made, make

it plainer. Meanwhile both comets, [that] of the year 1618 and [that of] 1652, confirm the said phenomena. For since in the comet of the year 1652 the end of the tail was always by no small amount farther from the Earth than the head, as the table above on page 533 shows, the tail of this comet necessarily appeared pointed, and also paler and more diluted. Conversely, the end of the tail of the comet of the year 1618 was, from December 1 to 8, less far from the Earth than the head; but from that time on the tip was continually removed more and more, so that at the last appearance it was more than 100, indeed 150, semidiameters of the Earth farther away, as can be seen from the table on page 535. Accordingly the tail of that comet too appeared at first much wider, thicker and brighter around the end than toward the close, when it was then found to be not only more pointed but also thinner and paler.

[Margin: Quorum Cometarum cuſpides ſunt ſplendidæ, eorum capita, ipſis caudarum extremitatibus à nobis ſunt remotiora.] *Comets whose tips are bright have heads farther from us than the ends of their tails.*

[Margin: Exemplis probatur.] *This is proved by examples.*

Since, then, there is no longer any doubt that in comets the ends of the tails are not rarely much nearer to the Earth than the heads themselves, the question arises how far these tips can reach toward the Earth. In the first place it must be known that

[Margin: Quousq́; & an ad ipſam Terram cuſpis alicujus Cometæ pertingere poſſit ?] *How far, and whether, the tip of any comet can reach the Earth itself.*

according to the different true length of the tail and the varying distance of the comet from the Earth and from the Sun, the tip of the tail is more or less distant from the Earth; but the tip is nearest of all at the very conjunction with the Sun, as we have already stressed quite often. Further, when [the comet] is in conjunction and the tail is equal in length to the comet's distance from the Earth, the tip of the tail exactly grazes the surface of the Earth. But given a tail somewhat shorter than the distance of the head from the Earth, the difference between the two indicates how far the tip is removed from the Earth. Conversely, with a tail longer than the distance of the head, the tail would graze the Earth, indeed cover it, and would, as it were, surround us with its rays.

[Margin: Poſſe caudam ſuo tempore Terram tegere.] *That a tail can, in its time, cover the Earth.*

If you ask, moreover, whether such a tail, reaching all the way to the Earth and passing through it, could also be seen or detected: in my opinion, not at all. This is for the reason that this very thing could never happen except at the very conjunction with the Sun, and then by day (at night, however, neither the Sun nor the comet can then be seen in any way); but by day we perceive no rays except ones like the Sun's rays passing through clouds, or like some more vivid sunlight. And so that tail of the comet, clinging to the Earth at that time, would appear to us in no other form than as if some trembling radiation, or a

tremulous darting of the Sun's rays, or some unusual flash in the air presented itself to us, or rather it would be seen like an immense fire below the heavens. This phenomenon, however, would not last long, but would be of very short duration; and apart from it nothing at all would be noticed.

[Margin: An cauda Terram radens ab incolis Terræ deprehendi posſit ?] *Whether a tail grazing the Earth can be detected by the inhabitants of the Earth.*

[Margin: Quâ facie illa nobis appareret.] *With what appearance it would appear to us.*

In the Sun itself, however, I think we would notice some greater alteration and change with the tail so placed on the Earth, especially if the parallax allows it: if the body, together with the tail, set itself before the Sun and intercepted its light, then, I say, the Sun would appear with a gloomy and darkish disc, entirely stripped of its luminous rays, so that it would in a way be darkened and would suffer a strange eclipse of some kind — with almost the same appearance in which at other times the Sun has suddenly presented itself, the sky being otherwise still, as if stripped of all light, or sprinkled with a strange and singular colour or redness. Examples of these we meet here and there in history, and we have also noted them in their place. I add that if at the same time the head of the comet itself, composed of matter that is otherwise very dense and of very numerous and very solid nuclei, placed itself between the Sun and us, it is certainly not absurd that some very dark eclipse could arise, indeed unusual and dreadful darkness by day — and lasting not merely one hour or another, but even several days, quite long-lasting according to the motion of the Sun and of the comet.

[Margin: Sol à Cometâ certo tempore poteſt obſcurari; imò eclipſari.] *The Sun can be darkened by a comet at a certain time; indeed, eclipsed.*

[Margin: Quâ ratione horrendæ tenebræ etiam aliquot dierum, ex Cometâ quopiam, induci posſint·] *How dreadful darkness, even of several days, could be brought on by some comet.*

On this matter the following thought has occurred to me: that something similar befell the Sun at the time of the Passion of Christ, when the Sun suffered an extraordinary eclipse at the very full moon. For if it so pleased God, Best and Greatest, a certain comet could certainly, at that very time, have placed itself between the Earth and the Sun in such a way that such unusual and very dark darkness was brought on to the greatest degree. But since, to produce such a phenomenon, many things must come together at once, I am entirely of the view that at another time it can happen very rarely indeed.

[Margin: De obſcurato Sole, tempore Paſſionis Chriſti, quid Autori videatur.] *What the author thinks about the darkening of the Sun at the time of the Passion of Christ.*

I do not, however, believe that no comet tails at all can come into view by day; but only that they vanish at the very conjunction

[Margin: An Cometarum caudæ, etiam de die ſub adſpectum cadãt ?] *Whether the tails of comets come into view even by day.*

with the Sun; but in another position it can certainly happen that, in certain comets brighter than the rest and shining with very bright rays, tails are sometimes seen: as actually happened in the comet of the year 1618, which at a certain time shone by day together with the Sun itself. Other comets of this kind have also existed, as is clear from the following examples. Thus in the year 47 before the birth of Christ, in the consulship of M. Antonius and P. Dolabella, at the Games of Venus Genetrix, which Augustus held on behalf of the college, a haired star rose for seven days beneath the Septentriones, at the eleventh hour of the day; and it was bright and visible in all lands. Plin. Jul. Obseq. 2. In the year after the birth of Christ 367, while the Emperor Julian was waging war against the Persians, etc., a comet, together with other terrible prodigies, was seen on a clear day. Rockenb., without an authority. 3. In the year 684 there are those who write that in the time of Pope Benedict a star appeared near the Vergiliae for several days and nights in a clear sky, between the Lord's Nativity and the Epiphany. Platina. Calvisius adds, from Anastasius, that it was of dull light, like the moon, but was seen only by night. 4. In the year 874 a huge star, preceding the moon for the whole month of April, with fiery rays stretched out lengthwise, was seen by night and by day, not without dread. Hect. Boethius. 5. In the year 1269 a comet of wonderful size was seen every day around noon. Hect. Boeth.

[Margin: Cometæ, qui interdiu ſplendente Sole, conſpecti fuerint.] *Comets that have been seen by day while the Sun was shining.*

With these, then, let us at last bring to an end our quite lengthy discussions of the apparent size of the tail, and of that variation which arises from the varying position of the comet relative to the Sun and from the varying angle of vision — the tail, that is, being taken as of the same length at all times — and hasten on to other matters. In particular, let us inquire whether the true size of the tail also undergoes some variation, and from what cause. We have indeed already touched on this matter in this Book; but since it was not possible to treat it fully there, we have gladly deferred it to this place. From what has been said here and there in this Book, however, it is easily gathered — above all where we dealt with that more dilute matter accompanying the comet, suited to receiving and holding the solar rays — that the true length of the tail must vary, no differently from the apparent length, with the comet's varying distance from the Sun and its position relative to the Earth, and that the tail must now draw in, now spread out. For the Creator and Director of the Universe does not produce the head and tail of a comet immediately, at the very outset, nor does he at once impress a motion on it, so that it thrusts itself on our eyes as though compelled. Rather, in our view, comets are generated gradually, each in its own time, from a certain suitable matter; and no less do their tails also become longer and shorter, according to the greater or lesser quantity of the matter accompanying the comet, or its head, and according to that matter's expansion or compression. Add to this: the closer comets travel to the Sun, and [the more] the head is composed of more solid and more compact nuclei or

corpuscles, the longer and denser the tails they have. This can be recognized from the following. First, the solar rays are the stronger and more vigorous the nearer they are, and the more easily they pass through the transparent body and extend lengthwise. Next, a stronger reflection also takes place at the surfaces of more solid bodies. But just as this radiation, refraction and reflection about comets is subject to many changes from day to day, so too the true lengths of tails change gradually, and not a little: they grow and decrease.

[Margin: Vtrùm vera quoq́; caudæ longitudo, variationi, & unde obnoxia ſit ?] *Whether the true length of the tail is also subject to variation, and from what cause?*

[Margin: Pro amplitudine atmoſphæræ Cometicæ,nunc majores, nunc minores per ſe ſunt.] *According to the extent of the cometary atmosphere, they are in themselves now greater, now smaller.*

[Margin: Cometæ quò Soli ſunt viciniores, eò lucidiores prolixioresq́; exhibent caudas.] *The nearer comets are to the Sun, the brighter and longer the tails they display.*

From this it is inferred that the opinion of certain philosophers is entirely contrary to reason: those, namely, who hold that tails are longest straight away, at the very first rising of comets; and it makes no difference whether you understand the true or the apparent length of the tail. If you take it as the true length, nothing at all prevents me from holding the exact contrary: namely, that at the beginning tails are necessarily shorter than in the course of time, or even at the very end. For just as a comet at the outset takes its beginnings from some very small and rather thin matter, as we have shown in its place, so too that more dilute matter does not flow to the head so immediately, within the space of one hour or another, in such abundance that nothing more could be added to it or grow onto it from day to day — not at all. Rather, it is usually increased in the course of time, according to the greater matter met on its path; and so a tail is not at once tall, much less of the greatest bulk, at the beginning, in whatever region of the heavens the comet may blaze up. Indeed, even when the comet's head is already decreasing, when the bodies and nuclei begin to dissolve again and the matter grows rarefied and recedes, the tail nevertheless appears to grow still more than around the first appearance; for at that time that more dilute matter surrounding the head fills a larger space than at the beginning, when it first gradually takes on its increments. Moreover, even though the comet has already reached full maturity, that thinner matter around the comet is nonetheless more contracted than around the end, when the bodies and that matter are already being thinned and dissolved. Sometimes, however, the matter surrounding the head is better suited on one day than on another to receiving and holding the solar rays; and on this day rather than on that, more matter departs from that rarer medium surrounding the head than accrues to it. And so tails are not in fact continuously increased and diminished according to some fixed proportion; rather, without rule they now grow, now decrease, as

we clearly demonstrated a little earlier from the comets of the years 1618 and 1652 and from their calculation.

[Margin: Nonnulli, caudas esſe ab initio longisſimas ſtatuunt.] *Some hold that tails are longest from the beginning.*

[Margin: Contrarium propemodùm veriſimilius esſe.] *That the contrary is almost more likely.*

[Margin: Caudæ creſcunt, & decreſcunt, absq́; omni proportione, & lege.] *Tails grow and decrease without any proportion or rule.*

Although these things can no longer be denied — namely, that the true length of the tail is subject to remarkable changes — I shall nevertheless set before everyone's eyes still more clearly, with certain figures, that tails have in no way at all kept always the same lengths from beginning to end, but have changed exceedingly. For this purpose we have laboriously investigated by calculation, beginning from December 20 and continuing to January 8 — taking as given the longitude and latitude of the comet of the year 1652, its distance from the Earth, and also its distance from the Sun — namely, how great the apparent length of the tail would have been, granted that the comet kept the true length of its tail unchanged throughout, at 28 semidiameters of the Earth, such as it in fact also had on December 20, when [the tail] appeared to us as 7°. This apparent tail, worked out by calculation, together with the angles at the comet, and also how long it could have appeared at its longest, along with certain other matters bearing on this, we have put into the following little table.

[Margin: Quanta extitisſet apparens cauda Cometæ 1652, ſingulis diebus datâ ſc. verâ longitudine caudæ 28 Sem. T.] *How great the apparent tail of the comet of 1652 would have been on each day, given, namely, a true length of the tail of 28 semidiameters of the Earth.*

A little table showing how great the tail of the comet of the year 1652 would have appeared on each day, if it had always remained of the same magnitude, namely 28 semidiameters of the Earth, about as great as it was on December 20; the interval of the Sun from the Earth being supposed at its least, 5063 semidiameters [Tabella,exhibens quanta ſingulis diebus apparuisſet Cauda Cometæ Anno 1652,ſi perpetuò manſisſet ejusdem quantitatis, nempe 28 Semidiam. Terræ,quanta ferè fuit 20 Decemb. ſuppoſito Intervallo Solis à Terrâ minimo 5063 Semidiametr.]

	True longitude of the Sun (deg., min.)	True longitude of the comet (deg., min.)	Latitude *vena* [recte: vera, true] of the comet (deg., min.)	Interval of the comet from the Earth, C T (semid. of the Earth)	Apparent distance of the comet from the Sun, S T C. (deg., min.)	Angle at the comet between the Sun and the Earth, S C T. (deg., min.)	Apparent length of the tail in this position of the comet (deg., min.)	How long this tail could have been seen at such an interval (deg., min.)	Distance of the comet from the Sun for the tail to be seen at its longest (deg., min.)	Corresponding angle at the comet between the Sun and the Earth, S C T. (deg., min.)
December 20	29° 39′ ♑	24′ ♊	30° 49′ *A.*	110	143° 10′	36° 6′	7° 0′	14° 45′	74° 3′	104° 45′
21	0° 40′ ♑	36′	20° 2′	110	147° 34′	31° 47′	6° 17′	14° 45′	74° 3′	104° 45′
22	1° 41′	1° 40′	10° 45′	111	148° 17′	31° 5′	6° 6′	14° 37′	74° 10′	104° 37′
December 23	2° 43′ ♑	39° 24′ ♋	36° 2′ *A.*	114	146° 34′	32° 44′	6° 17′	14° 13′	74° 32′	104° 13′
24	3° 44′	27° 34′	3° 24′ *B.*	124	143° 42′	35° 29′	6° 19′	13° 3′	75° 35′	103° 3′
25	4° 45′	26° 2′	8° 41′	146	140° 48′	38° 11′	5° 53′	11° 3′	77° 20′	101° 3′
December 26	5° 47′ ♑	34° 42′	19° 4′ *B.*	189	137° 15′	41° 21′	5° 2′	8° 31′	79° 22′	98° 31′
27	6° 48′	23° 35′	16° 36′	265	134° 18′	43° 38′	3° 52′	6° 3′	80° 58′	96° 3′
28	7° 49′	22° 42′	19° 26′	384	131° 43′	45° 11′	2° 49′	4° 11′	81° 29′	94° 11′
December 29	8° 51′ ♑	22° 2′	21° 35′ *B.*	562	129° 31′	45° 54′	1° 59′	2° 51′	80° 47′	92° 51′
30	9° 52′	21° 28′	23° 25′	817	127° 32′	45° 49′	1° 22′	1° 58′	78° 45′	91° 58′
31	10° 53′	21° 4′	24° 58′	1166	125° 48′	44° 51′	0° 57′	1° 23′	75° 18′	91° 23′
January 1	11° 55′ ♑	20° 38′	26° 22′ *B.*	1630	124° 5′	43° 12′	0° 40′	0° 59′	70° 14′	90° 59′
2	12° 56′	20° 21′	27° 35′	2233	122° 35′	40° 43′	0° 28′	0° 43′	63° 7′	90° 43′
3	13° 57′	20° 4′	28° 42′	3000	121° 8′	37° 39′	0° 20′	0° 32′	53° 8′	90° 32′
January 4	14° 59′ ♑	52′ ♋	29° 40′ *B.*	3957	119° 48′	34° 10′	0° 14′	0° 24′	38° 12′	90° 24′
5	16° 0′	19° 44′	30° 33′	5134	118° 34′	30° 29′	0° 9′	0° 18′	9° 33′	80° 27′
6	17° 1′	19° 43′	31° 21′	6563	117° 28′	26° 48′	0° 7′	0° 11′	39° 31′	50° 29′
January 7	18° 2′ ♑	39° 44′	31° 56′ *B.*	8277	116° 29′	20° 5′	0° 4′	0° 7′	52° 17′	37° 43′
8	19° 4′	19° 49′	32° 29′	10311	115° 33′	23° 16′	0° 5′	0° 5′	60° 35′	29° 25′

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It is therefore evidently gathered that, even if the true length of the tail had constantly remained 28 semidiameters of the Earth, the apparent [length] would nevertheless have decreased gradually and in proportion, as the calculation under the eighth column clearly shows, so that it would have been diminished from 7° to 5′. Again, if the observed apparent length of the tail entered in the third little table on p. 533 is compared with this apparent length of ours, explored by calculation, we notice a truly notable difference: namely, that straight after December 20 the tail appeared much smaller than the present little table indicates. For on December 23 we found it only 5° long, whereas the apparent [tail] ought to have been seen at 6° 17′, [the true length] always remaining the same. But since it was observed as only 5°, it must necessarily have decreased in reality. The same is shown by the observations of the 24th and the 26th. Conversely, on the 27th the true length grew in turn, and was as great as it was given on December 20. For the apparent length was observed as 4°, and that worked out by calculation was also nearly as great; therefore it was in fact increased with respect to the preceding day. Likewise, on January 1 and 4 as well, the true length of the tail grew. For its apparent length [was] noted at 2°, whereas, with the same true length of 28 semidiameters of the Earth always supposed, it would have appeared only 7′ or 5′. This is equally easy to demonstrate from the angles at the comet between the Sun and the Earth, if they are duly compared.

[Margin: Eâ ratione cauda apparens ſenſim decrevisſet.] *In this way the apparent tail would have decreased gradually.*

[Margin: Cauda,reips[[â/à]] decrevit.] *The tail actually decreased.*

[Margin: Rursùs crevit.] *It grew again.*

But so as not to dwell on these matters any longer, let us now go on to investigate how great the cone of the tail of the comet of the year 1652 was on certain days, given, namely, the length of the tail and the area of the circular disc of the head, found in the preceding Book. This is not at all laborious, especially since the comet always shone with a pyramidal tail. Right reason, moreover, suggests that, just as the area of the head and the tail were very ample, so too the conical solidity of the tail was immense; and in cubic miles it is so great that we may rightly marvel at it greatly. But to sum the matter up in a few words, here is a little table for you, [giving] for each day not only the conical solidity of the tail, but also the apparent diameter of the head; the interval of

583 On the page the table is boxed at the head of the leaf, with its title inside the frame. The first column carries the day numbers, with the month printed sideways once beside each group of rows (Decem., Januar., Jan.); horizontal rules divide the rows into seven groups, the month standing at the head of each group here. The column heads are set in italic, with the triangle letters (C T, S T C., S C T.) in roman capitals; the units stand in a separate row (Gr.M., Gr.Min., Sem.T.), given here in brackets in the heads. Each angle is printed as two figures, degrees and minutes. The zodiac signs stand only in the first row of each group, and A. and B. (north and south latitude) only where shown. The fourth head prints vena where the second and third heads print vera.

the head from the Earth; likewise the true diameter of the head, [and] the area of the circular disc of the head; and also the length of the tail. It will not be out of place to have investigated all of these thoroughly, in their proper time.

Conical solidity of the comet's tail in the years 1652 and 53 [Soliditas Conica Caudæ Cometicæ Anno 1652 & 53.]

Month, day	Apparent diameter of the head (min., sec.)	Interval of the head from the Earth (semid. of the Earth)	True diameter of the head (miles)	Area of the circular disc of the head (square miles)	Length of the tail (miles)	Conical solidity of the tail (cubic miles)
December 20	30′ 0″	110	825	535174	23700	4227.870000
23	28′ 0″	114	800	502000	18360	3072.240000
25	25′ 0″	146	914	655795	5502	1202.730000
December 26	24′ 0″	189	1134	1010394	8946	3013.000000
27	22′ 0″	265	1502	1772360	24920	14728.300000
30	16′ 0″	817	3270	8398995	17400	48714.200000
January 3	7′ 0″	3000	5260	21702760	154500	1117690.000000

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But if you ask, in addition, whether the cone of the tail of comets always follows the cone of the comet's shadow, and always imitates the same form and figure: I answer that the heads of comets indeed, as we cannot deny, cast a shadow turned away from the Sun, since they consist of very many bodies, most opaque and most dense. Yet this shadow of comets is never truly so dark and dense as that of the other planets, much less of the Earth. For usually a rarer and more diluted transparent matter is intermixed with those more opaque bodies set in the head; very many of the Sun's rays pass through this matter by refraction, and so partly illuminate the shadow of comets again, and make it whitish and quivering, or flashing. From this it necessarily follows that the comet's shadow is always very thin and faintly luminous: unless perhaps the

[584] On the page the table stands boxed between the two paragraphs, with its title above the frame. The month is printed once before the first row of each group (Decemb., Januar.); horizontal rules divide the rows into three groups, December 20–25, December 26–30 and January 3. The column heads are set in italic; the units stand in a separate row (Menſ. Dies, Mi. Sec., Sem.Ter., Milliar., Milliar.Quadr., Milliaria Cubica.), given here in brackets in the heads. The apparent diameter is printed as two figures, minutes and seconds. In the last column each figure is printed with a low point followed by six figures; the figures before the point count millions of cubic miles, as the product of the area and the length, divided by three, shows.

head of some comet were made up either of a single, most solid nucleus or of fewer, very large bodies; then, I say, this shadow too can occur much thicker.

By no means, however, does the cone of the tail imitate the cone of the shadow. For, as has been shown in its place, the shadow certainly does not at all produce the tail; rather, the Sun's rays refracted through the head and reflected in the head, which are stopped and bounded in that rarer matter surrounding the head so that they can be seen, display the tail. Therefore, the more vivid and stronger these rays are, and the more ample that matter accompanying the comet is, and the more extended behind the comet, the larger the tail is found, and

[Margin: Coni magnitudo caudæ Cometæ 1652.] *The size of the cone of the tail of the comet of 1652.*

[Margin: Admirabilis ſoliditas caudæ Cometicæ.] *The astonishing solidity of the comet's tail.*

[Margin: Num conus caudæ, conum umbræ, quà formam figuramq́; æmulatur ?] *Whether the cone of the tail imitates the cone of the shadow in form and figure.*

[Margin: VmbraCometarum dilutior eſt Planetarum umbrâ.] *The shadow of comets is more diluted than the shadow of the planets.*

[Margin: CometarumComa cum umbrâ eorum nihil habet commune.] *The coma of comets has nothing in common with their shadow.*

the more and more it unfolds itself lengthwise. So the coma of comets has nothing whatever in common with their shadow, neither in length nor in breadth, since the shadow can be now longer, now shorter than the tail. The shadow, however, claims for itself a certain and definite length, since it depends on the distance from the Sun and on the size of the comet's head. Here I would like you to note at the same time that when the true diameter of the comet's head exactly equals the Sun's diameter, the shadow is infinite and takes on a form not conical but cylindrical. But given a cometary body smaller than the solar body, the shadow must necessarily be of conical figure. Moreover, the farther the comet is removed from the Sun, the longer the cone is; again, the nearer it is, the shorter the shadow is, as optics teaches. Hence it can certainly happen that in some comets the shadow is sometimes much longer, [and] also shorter, than the tail itself. Meanwhile we shall not go astray if we grant that in comets greater in bulk the shadow is usually greater than the tail.

But so that the matter may become more certain, let us go and explore all these things not only in the comet of the year 1652, for the individual days on which it was observed and its conical solidity was worked out, but also in some others, namely at the time when the tail appeared nearly at its greatest. The calculation is set up in this way. First, the interval of the comet from the Sun is to come out, namely in the oblique-angled rectilinear triangle S T C, in which let S be the Sun, T the Earth, C the comet: from the givens S T, the interval of the Sun from the Earth, and the distance of the comet from the Sun, and the

angle at the comet, [there comes out] the side C S, namely the interval of the comet from the Sun.

2. Let the true semidiameter of the comet, B C, be subtracted from the semidiameter A S of the larger figure; A E remains. Now as A E is to E B, so B C is to C F; or, what is the same, as A E is to B C, so E B is to C F, the length of the shadow sought, since the triangles are similar. Semidiameters of the Earth therefore result, and these are to be converted into German miles by means of logarithms, so that you have the length of the shadow sought, following the course of the calculation below.

Diagram. A geometrical figure of the Sun, the Earth and a comet with its shadow. At the right a large circle stands for the Sun, with S inside it, A at its top and E just inside the circle below A. At the lower centre a small circle carries T. At the upper centre-left a small circle stands for the comet's head, with B above it and c beside it to the right. Straight lines run from the large circle past the small upper circle and converge toward the upper left, where F stands; a line joins the comet's circle to the circle T, and a horizontal line joins T to the large circle. At the lower left is engraved *Autor ſculpſit.* (Engraved by the author).

- F (upper left, where the lines converge): F
- B (above the comet's circle): B
- c (right of the comet's circle, a line passing through it): c
- T (inside the small lower circle): T
- A (top of the large circle): A
- E (inside the large circle, below A): E
- S (inside the large circle): S
- Autor ſculpſit. (lower left): Engraved by the author

As S C T to S T, so S T C to S C. As A E to B C, so S C to F C.

Calculation of the length of the comet's shadow in the year 1652, assuming an interval of the Sun at perigee of 5063 semidiameters of the Earth and a semidiameter of the Sun of 23 93/100 semidiameters of the Earth [Calculus Longitudinis Umbræ Cometicæ Anno 1652,ſuppoſito Intervallo Solis Perigæi 5063 Sem. T. & Sem. Solis 23 93/100 Semid. Terræ.]

December 20 [Decembr. XX.]

68062 — *Logarithm* ST — 5063 *semidiameters of the Earth, interval of the* ☉ — 2393 AS *semidiameter of the Sun*

A. 51168 — *Logarithm* STC — 143° 10′ *distance of the comet from the* ☉ — *S.* 145028 — *Logarithm* AE — 2345

119230 — 455216 — *Logarithm* CF — 105 *semidiameters of the* ♁*, length of the shadow sought*

S. 52900 — *Logarithm* SCT — 36 6 *angle at the comet* — *A.* 245342 — *Logarithm* — 860 *miles*

66330 — *Logarithm* SC — 5151 *semidiameters of the Earth, interval of the comet from the* ☉

A. 533914 — *Logarithm* BC — 48 (2) *semidiameters of the Earth, semidiameter of the comet* — *S.* 690775 — *Aſcit. III.*

600244 — 9783 — *Logarithm* CF — 90680 *miles*[585]

[Margin: De longitudine, atqu[[è/é]] figurâ umbræ Cometicæ.] *On the length and figure of the comet's shadow.*

[Margin: Vmbra modò longior, modò brevior ipsâ caudâ eſſe poteſt.] *The shadow can be now longer, now shorter than the tail itself.*

[Margin: Methodus calculi, pro inveniendâ longitudine umbræ Cometicæ,anno 1652.] *Method of calculation for finding the length of the comet's shadow, in the year 1652.*

December 23 [Die Decemb. XXIII.]

68062 — *Logarithm* ST — 5063 *semidiameters of the Earth*

A. 59608 — *Logarithm* STC — 146° 34′

127,670

S. 61484 — *Logarithm* SCT — 32 44

66186 — *Logarithm* SC — 5159 *semidiameters of the Earth*

A. 538170 — *Logarithm* BC — 46 (2) *semidiameters of the Earth*

604,356 *Sum* — 2393 SA

S. 144943 — *Logarithm* AE — 2347

459413 — *Logarithm* CF — 101 *semidiameters of the Earth*

A. 245342 — *Logarithm* — 860 *miles*

704,755

S. 690,775 — *Aſcitit. III.*

13980 — *Logarithm* CF — 86950 *miles*

December 25 [Decembr. XXV.]

68062 — *Logarithm* ST — 5063 *semidiameters of the Earth*

A. 45882 — *Logarithm* STC — 140° 48′

113,944 *Sum*

S. 48098 — *Logarithm* SCT — 38 11

65846 — *Logarithm* SC — 5176 *semidiameters of the Earth*

A. 523840 — *Logarithm* BC — 53 (2) *semidiameters of the Earth*

589,686 *Sum* — 2393 AS

S. 145243 — *Logarithm* AE — 2340

444443 — *Logarithm* CF — 117 *semidiameters of the Earth*

A. 245342 — *Logarithm* — 860 *miles*

[585]The calculation stands on the page without a ruled grid, in two blocks side by side; it is set here line by line as printed, the left block first and then the right block, each figure in its printed order; the dashes stand for the printed spacing, not for printed marks. The right block begins with 2393 AS, set a little higher than the first line of the left block; the line 700558 belongs to the right block. Printed rules stand under A. 51168, under S. 52900 and under A. 533914 in the left block, and under 2393, under S. 145028, under A. 245342 and under S. 690775 in the right block. The figures 36 6 are printed without degree and minute marks; 143° 10′ carries them. The figure 48 is followed on the page by a 2 in round brackets. The letters A. and S. before figures and the label Aſcit. III. are kept as printed. ☉ is the Sun's sign and ♁ the Earth's, as printed.

689,785
S. 460,517 — *Afcitit. II.*
229268 — *Logarithm* CF — 101000 *miles*
December 26 [Decemb. XXVI.]
68062 — *Logarithm* ST — 5063 *semidiameters of the Earth*
A. 38743 — *Logarithm* STC — 137° 15′
106,805 *Sum*
S. 41452 — *Logarithm* SCT — 41 21
65353 — *Logarithm* SC — 5202 *semidiameters of the Earth*
A. 504109 — *Logarithm* BC — 65 (2) *semidiameters of the Earth*
569,462 — 2393 SA
S. 145758 — *Logarithm* AE — 2328
423704 — *Logarithm* CF — 144 *semidiameters of the Earth*
A. 245342 — *Logarithm* — 860 *miles*
669,046
S. 460,517 — *Afcit. II.*
208529 — *Logarithm* CF — 124300 *miles*
December 27 [Decemb. XXVII.]
68062 — *Logarithm* ST — 5063 *semidiameters of the Earth*
A. 33450 — *Logarithm* STC — 134° 18′
101,512 *Sum*
S. 37100 — *Logarithm* SCT — 43 38
64412 — *Logarithm* SC — 5251 *semidiameters of the Earth*
A. 477004 — *Logarithm* BC — 85 (2) *semidiameters of the Earth*
541,416 *Sum* — 2393 AS
S. 146620 — *Logarithm* AE — 2308
394796 — *Logarithm* CF — 193 *semidiameters of the Earth*
A. 245342 — *Logarithm* — 860 *miles*
640,138 *Sum*
S. 460,517 — *Afcitit. II.*
179621 — *Logarithm* CF — 165900 *miles*
December 30 [Decemb. XXX.]
68062 — *Logarithm* ST — 5063 *semidiameters of the Earth*
A. 23193 — *Logarithm* STC — 127° 32′
91,255 *Sum*
S. 33252 — *Logarithm* SCT — 45 49
58003 — *Logarithm* SC — 5599 *semidiameters of the Earth*
A. 396266 — *Logarithm* BC — 190 (2) *semidiameters of the Earth*
454,269 *Sum* — 2393 AS
S. 151275 — *Logarithm* AE — 2203 (2)
302994 — *Logarithm* CF — 483 *semidiameters of the Earth*
A 245342 — *Logarithm* — 860 *miles*
548,336
S. 460,517 — *Afcitit. II.*

87819 — *Logarithm* CF — 415500 *miles*
January 3 [Januar. III.]
68062 — *Logarithm* ST — 5063 *semidiameters of the Earth*
A. 15552 — *Logarithm* STC — 121° 8′–
83,614 *Sum*
S. 49293 — *Logarithm* SCT — 37 39
34321 — *Logarithm* SC — 7095 *semidiameters of the Earth*
A. 348861 — *Logarithm* BC — 305 (2) *semidiameters of the Earth*
383,182 *Sum* — 2393 AS
S. 156638 — *Logarithm* AE — 2088
226544 — *Logarithm* CF — 1038 *semidiameters of the Earth*
A. 245342 — *Logarithm* — 860 *miles*
471,886 *Sum*
S. 460,517 — *Aſcit. II.*
11369 — *Logarithm* CF — 892500 *miles*[586]

The shadow of the other comets has also been computed in this way; together with the shadow of the comet of 1652, I set it before your eyes in this little table.

[Margin: Vera longitudo diverſorum Cometarum, ad diverſas hypotheſes.]
The true length of various comets, on various hypotheses.

The true length of the shadow cast away from the Sun by various comets, but according to the various solar hypotheses of various authors
[Longitudo vera Umbræ à Sole ex Cometis diverſis projectæ : Sed ad diverſas Hypotheſes diverſorum Autorum Solares.]

[586]The six calculations stand on the page without a ruled grid, in two blocks side by side: December 23, 25 and 26 in the left block, December 27, 30 and January 3 in the right block, each under its own centred date. They are set here block by block, the left block first, each printed line as one line, its figures in their printed order; the dashes stand for the printed spacing, not for printed marks. Each calculation follows the order of the December 20 calculation on the preceding page: the interval S T and the angle S T C give, with the angle at the comet S C T, the interval S C of the comet from the Sun; the semidiameter of the comet B C taken from the Sun's semidiameter A S (2393) leaves A E; and the length of the shadow C F follows in semidiameters of the Earth and then in miles. Printed rules stand under each line that begins A. or S. in the logarithm column and under each 2393. The angles at the comet (32 44, 38 11, 41 21, 43 38, 45 49, 37 39) are printed without degree and minute marks; the angles S T C carry them. The semidiameter of the comet is followed in every calculation by a 2 in round brackets, and the 2203 of December 30 is followed by one as well. December 23 and 26 print SA where the others print AS; December 30 prints A with no point before 245342; January 3 prints a short dash after 8′. The letters A. and S. before figures and the labels Aſcitit. II., Aſcitit. III. and Aſcit. II. are kept as printed.

Time	Hypothesis of the solar theory	Interval of the Sun from the Earth (semid. of the Earth)	Distance of the comet from the Sun (deg., min.)	Angle at the comet between ☉ and ♁ (deg., min.)	Rectilinear interval of the comet from the Sun (semid. of the Earth)	True diameter of the comet's head (miles)	True length of the shadow in (semid. of the Earth)	Length of the shadow in (miles)
			Year 1577					
November 13	Tycho	1110	39° 22′	132° 38′	957	368	41	35420
			Year 1590					
February 23	Tycho	1122	37° 26′	65° 37′	749	900	84	72270
			Year 1607					
September 16	Kepler	3410	54° 36′	118° 46′	3171	450	56	48030
			Year 1618					
December 9	Kepler	3350	57° 48′	120° 47′	3300	240	31	26440
			Year 1652 and 53					
December 20		5063	143° 10′	36° 6′	5151	825	105	90680
23		5063	146° 34′	32° 44′	5159	800	101	86950
25		5063	140° 48′	38° 11′	5176	914	117	101000
December 26		5063	137° 15′	41° 21′	5202	1134	144	124030
27		5063	134° 18′	43° 38′	5251	1502	193	165090
30		5063	127° 32′	45° 49′	5599	3270	483	415500
January 3		5063	121° 8′	37° 39′	7095	5260	1038	892500

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[587] On the page the table stands boxed below its title, in nine ruled columns. The column heads are set in italic over up to four lines; the units stand in a separate row (Sem.Ter., Gr. Mi., Sem.T., Mill., Milliar.), given here in brackets in the heads; the first two columns have no unit. The year lines (Anno 1577 and so on) are set in roman across the fourth and fifth columns, each between rules; they are given here in the fourth column. Each angle is printed as two figures, degrees and minutes. The second column, naming the author of the solar hypothesis, is blank in the rows of 1652 and 53. Rules divide the rows into groups: each row of 1577 to 1618 stands alone, and the rows of 1652 and 53 stand in groups of three (December 20–25, December 26–30) and one (January 3). The eighth and ninth heads end with in, the unit standing below.

You see, therefore, that the true length of the shadow of the comet of the year 1577 was only 41 semidiameters of the Earth, whereas the tail on that very day was 95 semidiameters of the Earth, as we learned on p. 535. The true length of the shadow of the comet of 1590 is found to be 84 semidiameters of the Earth, but the true length of the tail 252½ semidiameters. For the comet of 1607 the length of the shadow [was] 56 semidiameters of the Earth, but the true length of the tail 82½ semidiameters of the Earth. Likewise, for the comet of 1618 the length of the shadow [was] 31, but the true length of the tail 129 semidiameters of the Earth. And so in all of these the tail was longer than the shadow. By contrast, in the comet of 1652 the shadow beat the tail in length by a very great deal: for not only was it longer, up to 100 semidiameters of the Earth, until December 26, but also, around the last appearance, up to 500, indeed 800 semidiameters of the Earth. Therefore we rightly hold that there is sometimes a longer, sometimes a shorter shadow than the true tail of the comet, which is what had to be investigated.

Moreover, we rightly conclude from this that the length of the tail in no way depends on the comet's shadow, much less that the shadow has some common bond with the tail and that the two are held together by some kinship with each other, as Fortunio Liceti, among others, taught in chapter 13 of *De lucidis in sublimi* and in his book *De Cometis*: namely, that the tail can be seen in the comet's shadow. But in this respect he is mistaken. For the tail is seen not by reason of the shadow, but by reason of the more diluted matter poured around, which we have treated at length. For if the shadow were the genuine and only cause on account of which tails came into our sight, and outside the shadow no rays at all (whether these from the Sun or from the cometary body itself,

[Margin: Exemplis probatur, caudas Cometarum, nunc longiores, nunc breviores extitiſſe.] *It is proved by examples that the tails of comets have been now longer, now shorter [than the shadow].*

[Margin: Caudæ, ob umbram non in conſpectum veniunt; ut vult Lycetus, & Cyſatus.] *Tails do not come into view on account of the shadow, as Liceti and Cysat would have it.*

as Cysat would have it, issue, it makes no difference) were stopped, the tail would necessarily always present an appearance entirely like the shadow, and would never be longer than [the shadow] itself, granted that for other reasons a shorter tail can sometimes also be seen within the shadow itself. But that this is plainly false is proved by the preceding little table and by those four comets brought forward: namely, that their tails were truly very much longer than the shadow of the comets itself. Moreover, [it is proved] that other comets have been noted, such as those of the years 1577 and 1618, whose tails by no means ended in a sharp point, as the shadow of comets indeed usually does (since the illuminated cometary body is usually smaller than the illuminating body of the Sun), but were spread out around their ends and quite broad, and moreover showed a face not entirely straight but curved. The shadow, however, always proceeds absolutely straight and ends in a pyramidal apex. How, then, can the

tail follow the shadow in any way, much less be seen only in the shadow, as Liceti holds? For then the tail would always present itself to us straight and pointed. Added to this, the cometary shadow can never be broader than the diameter of the head. On the contrary, it has been shown abundantly enough that in very many [comets], as in the comet of 1618, the tail was wider than the head itself, and indeed that around its end it spread out further, to 3° and 4°. Therefore [that view] is overthrown again and again, in that the tail by no means follows the shadow, nor can be seen on account of it. The comet of the year 1652, it is true, seems to stand on Liceti's side, because it showed a tail tapering to a point like a cone, and also continually shorter than the shadow itself; but since so many examples go plainly to the contrary, this single one is by no means to be heeded.

But can it be that the shadow nevertheless contributes nothing whatever to the tail, especially if it is somewhat denser and darker? I would not altogether deny [that it contributes something]; but only to the extent that the Sun's rays passing through the comet's head could be made a little brighter and more vivid. For since the shadow is a little darker than the aether itself, a luminous body is certainly discerned more perfectly in darkness than in some other, brighter medium. Accordingly, in proportion to the extent of the shadow and its various degrees of opacity, the tail would be to some extent more conspicuous, especially around the head and its emergence from it. This is by no means contrary to experience either, although the tail may appear brighter in that place for other reasons as well (namely, that very many rays flow together there and intersect one another abundantly, as we have already proved elsewhere).

Granted, then, that comets can cast some more diluted shadow into the region opposite the Sun, it is further asked whether [it] can therefore also induce some eclipse in the fixed stars and planets, as happens to the Earth from the Moon. Since this question is not so very trivial, let us weigh it somewhat more deeply: first, whether it happens; then how and when. As regards the first question, I agree that comets can sometimes overshadow this or that planet, in a certain position relative to the Sun and the planet, especially if [the comet] were to cast so long a shadow. But I would like you to note, first, that to produce this phenomenon it is absolutely necessary that the comet be placed between the Sun and the planet it is to eclipse, or, what is the same, in

[Margin: Rationes, ob quas cauda umbram non ſequatur.] *Reasons why the tail does not follow the shadow.*

[Margin: Cauda Cometica nonnunquam amplior ipsâ umbrâ eſt.] *The cometary tail is sometimes broader than the shadow itself.*

[Margin: Vmbra, nihil quidem ad longitudinem, ſed ad claritatem caudæ quicquam conferre poteſt.] *The shadow can contribute nothing to the length of the tail, but something to its brightness.*

[Margin: An umbra Cometarum Stellas inumbrare, vel eclipſare poſſit?] *Whether the shadow of comets can overshadow or eclipse the stars.*

[Margin: Neceſſaria requiſita ad obſcurandos Planetas.] *The necessary requirements for darkening the planets.*

the very conjunction of the Sun be situated. Second, the comet's rectilinear interval from the Sun must always be less than the interval of the planet, or of some star, from the Sun. For any planet that enjoys a smaller interval than the hairy star can by no means be overshadowed. Third, it is also required that the true length of the comet's shadow always exceed the interval of the comet from the planet that is to be overshadowed. If even a single one of these requirements is lacking, an overshadowing of the stars is hoped for in vain.

From this it can easily be gathered that, although it is not contrary to nature that a comet can overshadow this or that planet, or some one of the fixed stars nearer to the Earth, nevertheless this very rarely comes into view, since these three requirements usually do not concur at the same time. For even if the comet is nearer to the Sun than the star is, the shadow itself is not on that account also equal in length to the interval of the comet from the planet that is to be hidden; or, if it does not fall short in this or that respect, the matter is interrupted because the comet and the planet are not in conjunction at exactly the same time.

In the obumbrations [obumbrationibus] of the planets among themselves, however, the case is very different. For although every planet, as opaque bodies do, casts a shadow, nevertheless they are not all able to hide one another, because now this requirement, now that one, is lacking; yet all of them are required together for this business of obumbration. But, to say in a few words what difference there is between the occultations and overshadowings [inumbrationes] of comets and of planets: one must know that since comets follow the course of no sphere according to which they exercise their motion, and so do not always revolve at the same distance from the Earth or from the Sun, but now at the elongation of this planet from the Earth, now at that of another, it follows that comets can at certain times overshadow any planets whatever, none excepted, and the Earth itself. Conversely, since the planets complete their period in definite circles and perpetually keep strictly to a certain distance, both from the Sun and from the Earth, it cannot happen that the planets individually overshadow or hide one another; nor can they alter the true length of the shadow as comets can (since their diameters always persist at the same magnitude). Finally, since they are very far apart from one another, the shadow does not allow one to be darkened or eclipsed by the other, if we consider them all.

But you ask which planets can overshadow one another? I would have you know that nothing certain can be determined on this matter unless you first assume a definite hypothesis. The Moon, however, can be darkened by the shadow of the Earth, and conversely the Earth by the shadow of the Moon, in every hypothesis. In the Ptolemaic hypothesis, and that of Alfraganus [al-Farghānī], Mercury can overshadow the Moon, Venus Mercury, and Jupiter Saturn and the fixed stars. In the hypotheses of the others, however, neither

can the Earth overshadow anything besides the Moon, nor can any planet overshadow any planet that is not its own companion; much less the fixed stars. The exception is the Tychonic hypothesis, according to which Saturn can indeed darken certain fixed stars, but cannot altogether hide them, because of their own light. The reason is this: the greatest shadows of the planets are shorter than the intervals of the planets, that is, than the distances by which they are removed from one another, as is plain to anyone from this little table.

[Margin: Non omnes Planetæ ſe mutuò inumbrare poſſunt.] *Not all the planets can overshadow one another.*

[Margin: Quid diſcriminis ſit inter Planetarum & Cometarum inumbrationes.] *What difference there is between the overshadowings of planets and of comets.*

[Margin: Quinam Planetæ mutuis obſcurationibus ſint obnoxii [[./,]]] *Which planets are subject to mutual darkenings.*

[Margin: Planetarum umbræ minores ſunt eorum intervallis.] *The shadows of the planets are smaller than their intervals.*

For in it you have the intervals of all the planets from the Sun, and the lengths of the shadow, carefully investigated by us — at the mean distance, namely — both in semidiameters of the Earth and in German miles.

True lengths of the shadows cast away from the Sun by the Earth, the Moon and the other planets, at their mean intervals from the Sun, with the true diameter of the Sun assumed at 41150 miles. [Longitudines veræ Umbrarum ex Terrâ, Lunâ, cæterisq; Planetis à Sole projectarum; in mediis ipſorum à Sole Intervallis, & ſuppoſitâ diametro verâ Sole 41150 Milliar.]

Names of the planets	Interval of the planet from the Sun	True diameter of the planet	Length of the shadow in	Length of the shadow in
	Semid. of the Earth	*Miles*	*Semid. of the Earth*	*Miles*
♄	49040	6335	8925	7675000
♃	26815	5590	4214	3624000
♂	7855	720	140	120300
♁	5157	1720	225	193400
♀	3734	1376	129	111100
☿	2000	301	15	12630
Full Moon.	5213	442	57	48670
New Moon.	5101	442	55	47630

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[588] On the page the table stands in a ruled frame at the right of a narrow column of text, beside the paragraph that follows it here, from its opening words to the clause on Jupiter's shadow hiding Saturn; its title is set inside the frame. The first column gives the signs of Saturn, Jupiter, Mars, the Earth, Venus and Mercury. Horizontal rules divide the rows into three groups: Saturn to Mars, the Earth to Mercury, and the two Moon rows. The unit row stands below the column heads, its first cell blank.

The conclusion therefore stands that the length of the shadow of any planet whatever (the Moon excepted) is far less than the interval even of neighbouring planets from one another. This, it is true, is not expressly noted in the attached little table; but the difference of the intervals of neighbouring planets shows it at once. For example: the distance between Jupiter and Saturn is found to be 22,225 semidiameters of the Earth, while the length of the shadow of Jupiter, which would have to hide Saturn, since it is nearer to the Sun, is only 4214 semidiameters of the Earth. Therefore, even if they were in close conjunction, Jupiter would nevertheless by no means overshadow Saturn. The case is indeed the same with the remaining planets, except the Earth and the Moon.

But to return to the comet of the year 1652: it is asked whether, at the distance from the Sun and the planets that it held on each day, it also overshadowed any wandering star [Erronem]? Certainly not, since in the whole time of its duration it came into conjunction with no planet. But if that had happened, it is further asked: would it also have overshadowed some planet? I do indeed firmly hold that it would, but Mars only, if it had been at perigee on January 3; for then the length of the comet's shadow would have exceeded the interval between the comet and Mars. But apart from this one alone, I say, it could have darkened none of all the remaining planets, both because of the comet's peculiar motion and because of the length of its shadow.

Finally, before we conclude these discussions of the shadow of comets, let us inquire how the shadow of comets compares with that of the planets: is that of the latter [the planets] or rather that of the former [the comets] greater and broader? If the matter is considered in general, it can certainly happen that the shadow of comets is as great as that of some planet, indeed of Saturn itself. For since the head of a comet sometimes far exceeds the very bodies of the planets, even of those most remote from the Earth, and moreover is not rarely removed from the Sun by an interval equal to Saturn's, a longer and greater shadow of comets can certainly occur. For the farther an opaque body is from the illuminating body, and the larger it is, the longer its shadow turns out, as is clearly established from optics.

But if you ask in particular whether any comet has ever blazed forth that cast a shadow entirely equal to the shadow of Saturn, I answer that, with so great a scarcity of more accurate observations of comets, it is not so easy to establish anything certain on this matter. For only five examples are available to us that shed even any light on this question. First:

[Margin: Longitudines umbrarum omnium Planetarum.] *The lengths of the shadows of all the planets.*

[Margin: An Cometa 1652 ullum Planetam obſcuraverit, vel obſcurare potuerit ?] *Whether the comet of 1652 darkened, or could have darkened, any planet.*

[Margin: VtrumCometarum; an verò Planetarum umbra major ſit.] *Whether the shadow of comets or that of planets is greater.*

[Margin: Quorundam Cometarum umbra quanta extiterit.] *How great the shadow of certain comets has been.*

the shadow of the comet of the year 1577, as is clear from the table inserted above on page 547, was greater by 26 semidiameters of the Earth than the shadow of Mercury alone; but it was smaller than the shadow of all the remaining planets. Second: the shadow of the comet of the year 1590. Since it is given as 84 semidiameters of the Earth, it was longer only than the shadow of Mercury and of the Moon. The comets of the years 1607 and 1618 also produced a nearly equal [shadow]. But the shadow of the comet of 1652 was at a certain time not only equal to the shadow of Mercury and of the Moon, but also exceeded in length the shadow of Venus, of the Earth and of Mars, up to January 3. Yet it by no means equalled the shadow of Jupiter and of Saturn, as is evident from the preceding little table — unless perhaps in the last days of its appearance, around January 8 and 10, the matter stood otherwise, when it had receded further and further from the Sun. This, however, we could not elicit [?] by calculation so accurately, because of the thinness of the body and the lack of observations. Let us therefore leave this question open, until in the course of time we learn something more from the appearances of more comets.

Lastly, I shall add yet another small question: whether any of the comets can be hidden or darkened by the shadow of all the planets, and also when this can happen? It is indeed affirmed, since a comet is a body altogether devoid of all light; but only at the time when it happens to come into opposition to the Sun with respect to that planet by whose shadow it is then to be eclipsed. And since comets do not perform their motion in some circle, as will be demonstrated in the next book, but are carried almost in a straight line, now through this part of the aether, now through that, it happens that they approach now this planet, now that, and pass through their shadow; so that comets are not incapable of being darkened and eclipsed not only by the shadow of the Earth but also by the shadow of all the others. Although this phenomenon has never, so far as I know, been detected by anyone, it is nevertheless beyond doubt that it can happen at some time. Campanella, indeed, in Book VII of the *Physics* [Phyſic.], article 7, on comets, asserts that comets have been seen to be eclipsed by the shadow of the Earth. But it is entirely hidden from me where, or from what observations, he drew this, and at what time this very thing happened, since he did not add his authority. However that may be, even if nothing at all certain is established on this matter, there is nevertheless no doubt whatever that, on our hypothesis, such a phenomenon can occur at times — but very rarely.

For just as lunar eclipses are not very frequent, especially total ones (even though the Moon completes its motion around the Earth twelve times in the space of one year, and keeps it fairly regular and periodic), so it is certainly no cause for wonder that comets can hardly ever be darkened by the shadow of the remaining planets. For it is necessary that many requirements for seeing this phenomenon concur at the same time; and that happens very rarely, and all the more rarely because hairy stars are the rarer spectacles of the heavens. Supposing

that some comet was once eclipsed, or darkened, in the very conjunction, I still hardly think that this was noticed by anyone. Indeed, even if they perhaps saw it, they could by no means be brought to believe that it was a true eclipse of the comet, arising from the shadow of some planet. For most of those ancient philosophers were carried along by a preconceived opinion: namely, that comets are generated and move only in the sublunary air. For the rest, however, I am thoroughly per-

[Margin: Vmbra Cometæ 1652 Martis umbram ſuperavit.] *The shadow of the comet of 1652 exceeded the shadow of Mars.*

[Margin: An Cometarum aliquis ab umbrâ alicujus Planetæ vel Terræ obſcurari poſſit ?] *Whether any of the comets can be darkened by the shadow of some planet or of the Earth.*

[Margin: Multa requiruntur ad obſcurationes Cometarum.] *Many things are required for the darkenings of comets.*

suaded that a comet could hardly ever be darkened so completely that no trace of light at all would remain. Even if it passed through the shadow of the Earth, it would nevertheless appear only somewhat darker, and redder or paler, and of a gloomier aspect than it otherwise would — like lunar eclipses, in which these colours are quite common; and indeed for exactly the same reasons as are given concerning the colours of eclipses. Nevertheless I do not deny that total eclipses can also sometimes occur in comets, as in the Moon, by which they are entirely extinguished, so that no trace remains, as was observed by us in the lunar eclipse in the year 1642. For comets likewise entirely lack light of their own. But just as such phenomena are rightly counted among rare occurrences, so too it is no wonder that they have so far been observed by no one.

In a similar way, now, just as a comet can be darkened by the shadow of the Earth, so too can it be darkened by the shadow of the remaining planets. For not only are comets sometimes removed from the Earth by an interval equal to that of the other planets, but they also reach the oppositions of the Sun and the planets; indeed, they approach the remaining planets so closely that they can be intercepted by the shadow of some planet. But the durations of such eclipses are not determined by anyone so easily as those of solar and lunar eclipses. For hairy stars exercise neither an always similar apparent motion nor an always similar true one; yet according to the speed and slowness of these [motions], such eclipses of comets would be now shorter, now longer.

It is now further asked whether such eclipses, or overshadowings, of comets can be both total and partial? This question depends entirely on the apparent diameter of the comet and of the shadow. For if the opposition is central, and moreover the apparent diameter of the comet and also that of the shadow around the comet's path are of the same magnitude, then a total overshadowing does indeed occur, but without delay [morâ]. But if the diameter of the shadow is greater than the comet's diameter, a total eclipse takes place with delay. Conversely, when the diameter of the comet somewhat exceeds the diameter of the shadow, or the comet passes not quite through the very centre of the

shadow but only toward its periphery, I would have you know that only partial eclipses of comets are to be expected. Accordingly a comet very rarely suffers a total failure of light [deliquium], except from the shadow of the Moon and of the Earth (because the apparent diameters of comets are usually smaller). The reason is this: the apparent diameters of the remaining planets, and so also their shadow, are usually smaller than the diameters of comets.

But in overshadowings of comets of that kind, if any should occur and be accurately observed, it is not beside the point now to ask with what appearance the tails of the comets would be seen? To begin with, since the head of the comet would take on one colour and brightness after another — by reason of the denser and darker shadow, and also of the refraction of the Sun's rays, as has been demonstrated elsewhere concerning lunar eclipses — the tail too, I think, while it runs through the interposed shadow together with the head, can be altered and changed in a certain way, in part and successively; indeed, it can sometimes be seen interrupted, as if some blacker ray clung to the tail. Yet if you look into the matter more deeply, it is entirely otherwise.

[Margin: An totalis Eclipſis Cometæ dari posſit.] *Whether a total eclipse of a comet can occur.*

[Margin: An duratio Eclipſium Cometarum, ut Solis & Lunæ, definiri queant?] *Whether the duration of eclipses of comets can be determined, like those of the Sun and the Moon.*

[Margin: Num Eelipſes [recte: Eclipſes] Cometarum tam totales quàm partiales ſint ?] *Whether eclipses of comets are both total and partial.*

[Margin: Cometa non niſi ab umbrâ Terræ vel Lunæ patitur totale deliquium.] *A comet suffers a total failure of light only from the shadow of the Earth or of the Moon.*

[Margin: Eclipſes Cometarum, quâ fa[[c/e]]ie appareant.] *With what appearance [?] the eclipses of comets appear.*

For although it can by no means be denied that the tail, in this way, is darkened just like the head itself, nevertheless that spectacle would by no means meet the eyes. For since every shadow, like the tails of comets too, descends from the Sun, it is absolutely necessary that both the shadow and the tail point toward the side opposite the Sun. For this reason, when the comet arrives at the opposition, or enters the shadow, the tail at once adapts itself to the length and course of the shadow, and inclines, and passes through the shadow together with the head; so that the overshadowing of the tail never indeed occurs after or before the darkening of the head, whether the comet is carried through the shadow of the Earth or through that of some other planet.

Nevertheless, there is a certain difference between the overshadowings of comets that arise by reason of the Earth's shadow and those that arise by reason of the shadow of the other planets. For when a comet passes through the Earth's shadow, we do not notice that darkening of the tail at all, however real it may be. For since we ourselves, as spectators, are situated in the very opposition together with the body and tail of the comet, the head of the comet

withdraws the tail entirely from our sight, while with respect to us it covers it completely with its body. For in the opposition of the comet and the Sun the tail vanishes entirely, and it is always found to be without coma, as we have shown elsewhere — unless perhaps the tail is curved and shows a notable inclination, and is also lit with a certain duller light by rays of the Sun refracted in the shadow (otherwise it would nevertheless vanish entirely together with the head itself, which I would have you note well). And then, I say, if the matter is examined more deeply, the tip of the tail would be eclipsed either a little sooner or a little later than the head itself; yet at the very moment of the opposition this would escape almost all sight.

But if the comet were darkened by the shadow of some other planet (although, as we have just said, the head is overshadowed together with the tail), we would nevertheless find the tail, at the very greatest overshadowing, darkened, if not wholly, at least in part: that is, when the spectators are situated outside that opposition of the comet and the Sun, and the comet itself is not so far from the Earth relative to the interval of the Sun. For on that condition we always see the tail under a certain angle of vision, and according to the comet's varying distance from the Sun, and depending on it, we notice now a larger, now a smaller portion of the tail, as I have set out abundantly in its place in treating the longest tail. But this holds on the express condition that the comet, while in the shadow, is lit to some extent by certain refracted rays of the Sun; otherwise this speculation is certainly merely ideal. To that extent, then, not only the head but also the tail would be observed darkened, in its own way. Unless, again, the comet were to make its opposition to the Sun with respect to us and the Earth, and also to the planet casting the shadow: then, I say, nothing at all of the tail would come into view, just as usually happens in opposition.

To make the matter clearer (since in itself it is not without obscurity), I shall explain it by the following figure, in which S represents the Sun; T the Earth in the great orb; C the comet in its orbit; *a b d* the shadow of the Earth; P the planet casting the shadow *g f h*. At A you see the comet moving upward along its path and passing through the Earth's shadow; and then that the head plunges into the shadow together with the tail, and so the tail likewise becomes invisible: if, name-

[Margin: Quidnam discriminis ſit inter obſcurationes, quæ ex umbrâ terræ, atq; iis,ex umbrâ aliorum Planetarum contingant.] *What difference there is between the darkenings that occur from the shadow of the Earth and those that occur from the shadow of the other planets.*

[Margin: In oppoſitione Cometæ & Solis cauda recta plan[[è/é]] exſtinguitur.] *In the opposition of the comet and the Sun a straight tail is entirely extinguished.*

[Margin: Poſſe in umbrâ aliorum Planetarum caudam quadantenus conſpici.] *That in the shadow of the other planets the tail can be seen to some extent.*

[Margin: Certâ tamen conditione.] *But on a certain condition.*

[Margin: Schemate omnia dilucidantur.] *Everything is made clear by a diagram.*

ly, the tail were to point entirely toward the side opposite the Sun, and also to proceed altogether in a straight line. But if it showed a curved or humped form, or were subject to a notable inclination, the head and the whole tail would not be darkened together. Rather, if it turned upward with its concave side, along the course of the orbit, the tip of the tail would be darkened a little sooner than the head itself and the rest of the tail, and in turn it would also leave the shadow sooner. The same would happen given a northern inclination. Conversely, given a southern curvature and inclination of the tail, the phenomenon would be entirely inverted, as is plainly evident at B and C. But the tail would be found darkened together with the head, under a certain angle of vision c T e, if the comet passed through the shadow of some other planet (as at P) — that is, with the Earth situated outside the opposition, and the comet's distance from the Sun and the Earth permitting it. Again, with the comet placed in opposition to the Earth and the Sun at once, in the same way, as at D: in that position, I say, you would by no means see the tail darkened, because the head stands directly in the way, unless the tail were endowed with a singular bending or inclination.

From this one also sees the reason, as I mentioned above, on page 526 of this book, why the tails of comets also entirely elude sight at the very opposition, unless they have a certain bend and inclination. For then the comet would display, as it were, a short beard, as is evident from the lower drawings of the attached figure. For that part of the tail which cannot be covered by the head because of its curvature and inclination, such as *l m*, would be seen even at the very moment of the opposition (provided, that is, that some secondary or refracted light clings to the head and the tail, or that the head suffers only a partial eclipse by reason of its latitude). Hence it comes about that then, with the curvature tending upward, the tail would shine with a shorter little beard stretched upward, in the aspect F; but with the curvature descending, or given a southern inclination, the comet would put forth its little beard downward, as at G.

On this occasion let us now also examine another phenomenon, which, being singular, has also as yet been touched on by no one (so far as I know), much less fully unravelled or demonstrated from a definite hypothesis: why, whether a comet revolves in opposition, or in conjunction, or even at some intermediate distance, the tails of comets appear by no means to point toward the side opposite the Sun, but are seen to deviate into an entirely different region of the sky, indeed sometimes by up to 90° from a straight line. Examples of this occur here and there in the authors; but of that kind I shall bring forward a little later only a single one, from Prætorius, to establish our opinion more and more firmly.

This phenomenon, however, arises from the fact that in opposition we by no means see the whole coma; yet if it were visible, it would be seen to deviate from the Sun toward the star *n* (in the attached figure). But since the eye takes in only the bent and inclined tip of the tail, *l m*, it seems to us to bend aside

toward the star *o*. And hence, if the calculation for the direction of the tail is made, it would by no means point toward *n*, but toward a different region of the sky, namely to *o*. And so this apparent deviation

[Margin: Quomodo breviſſimam barbam Cometa acquirat.] *How a comet acquires a very short beard.*

[Margin: Vnde coma plane in diverſas Cœli partes abire nonnunquam videatur; cùm tamen reverà in oppoſitum Solis vergat.] *Why the coma sometimes seems to go off into quite different parts of the sky, although in reality it points toward the side opposite the Sun.*

Diagram. A full-page engraved plate, with no text on the page. In the upper part, a large circle, the orbit of a planet, encloses a smaller circle, the great orb, with a rayed Sun at the centre. A comet's path runs as a straight line from the top of the plate down through the large circle, passing to the right of the small one; ten comet heads with feathered tails stand along it. Four dark discs on the small circle each cast a shadow cone away from the Sun, and a dark planet on the large circle casts a long cone that runs up to the apex of the plate. In the lower part, two horizontal rows each show a rayed Sun between two Earths on one line, with a star at each end of the line; beside each outer Earth a comet with a curved tail lies on the line, and a second comet head with a short tail stands off it. Stars marked o stand above the upper row and below the lower row. The labels engraved on the plate:

- *Trajectoria* (along the upper part of the path, reading downward) … *Cometæ.* (along its lower part): Path of the comet.
- *Orbita Planetæ.* (along the upper left arc of the large circle): Orbit of the planet.
- *Orbis Magnus.* (along the left arc of the small circle): The great orb.
- *Sol.* (left of the central Sun): The Sun. S (on the central Sun).
- c (10 instances): beside the comet heads on the path.
- e (9 instances): at tail ends along the path.
- E (near the top of the path), C (at its middle), A (lower down, beside a comet head).
- f (at the apex of the planet's shadow cone); g (left of the planet); P (below the planet); one mark right of the planet, crossed by the orbit line, not read (transcription line F11).
- d (on the left edge of the long cone running from the Sun past the uppermost disc on the small circle).
- D (above the uppermost disc on the small circle).
- T (4 instances, one at each disc on the small circle), each disc with an a and a b on either side (4 of each).
- b (3 further instances, at the ends of the shadow cones of the three lower discs).
- Upper row: S (on the Sun); T (on each Earth); n (at each star at the ends of the line); m and l (tail end and an intermediate point of each comet's tail); F (beside each comet head off the line).

- Lower row: S (on the Sun); T (on each Earth); n (at each star at the ends of the line); l and m (tail point and tail end of each comet); G (beside each comet head off the line).
- o (4 instances): two above the upper row, each over its star; two below the lower row, each under its star.
- *Fig. S.* (lower centre): Fig. S.
- *Autor ſculpsit.* (lower right, in script): Engraved by the author.

of the tail would be the greater, the more curved the tail was about its middle, and especially about its end. For the rarer medium surrounding the comet: the swifter the gradations of density or rarity it has, the more quickly, and as it were abruptly, [tails] are bent about the tip of the tail, as we have shown more fully elsewhere. From this it is indeed more than clear that bearded [comets] too (although it is a mere illusion of sight that their beard deviates so far from the Sun) can shine with that aspect at the very opposition; and even at the very moment of conjunction with the Sun, but with this difference: that only certain parts of the tail would present themselves to us, without the heads, since at that time the heads lie hidden under the very rays of the Sun. Of this, however, a reminder will be given below.

A quite similar phenomenon, unless I am mistaken, occurred in the comet of the year 1556, which shone about the beginning of March. Joh. Hommel described it carefully, and from him Joh. Prætorius, who reports among other things the following: *On March 5* (Old Style) *it stood near the left wing of Virgo, above Spica; on the eighth day below the knee of Boötes, and on the ninth day near Arcturus, etc.* Likewise, a little later: *Both its rays and its body were changed. And the rays, which in the evening* [pointed] *to the south, were directed to the west after midnight. Nor did it have a coma turned away from the Sun* (note well) *until it was less than a quadrant of a circle distant from the Sun.*

[Margin: Notabileexemplum deviationis caudæ à Joh. Hommelio obſervatum.] *A notable example of the deviation of the tail, observed by Joh. Hommel.*

First, we understand that, since the comet shone above Spica on the fifth of March, the Sun was at about 24° of Pisces, and the comet at that time at nearly 18° of Libra, and so was then scarcely 24° distant from the very point of opposition. Since, therefore, the comet stood nearly opposite the Sun, and indeed in a place even better suited to this phenomenon than the very point of opposition, it is not absurd that the tail appeared to deviate so enormously from the straight path, and indeed for the reasons given: namely, that the tail was strongly curved about its end and had a singular inclination. To this is added something that argues for it as strongly as possible: since at that time only the tip of the tail reached our sight, because of its position rather near the point opposite the Sun, it could not happen otherwise than that the comet then by no means showed a coma turned away from the Sun before it was less than a quadrant of a circle distant from the Sun. For as the comet withdrew more and more from the opposition, and the quadrature approached, where

the coma, otherwise much longer, is seen under a smaller angle of vision, the true direction of the tail could not be detected any sooner (as we noted before).

[Margin: Ita reverà accidisſe omnia [[-/a]] probatur.] *It is shown that everything really happened so.*

Examples of this, shining with the aspect described around the opposition of the Sun, have without doubt been very many, had they only been duly and exactly observed by our predecessors and handed down to us. In the comet of the year 1580, I think, something similar was detected by Mästlin. For he reports that at first [the comet] directed its tail with an oblique bend, but afterwards directed its coma entirely straight out from the Sun. This also seems very likely. For according to Rochenbachius it first shone on October 9, near the vernal equinox, advancing with retrograde motion through the signs of Pisces, Aquarius, Capricorn and Sagittarius. Therefore, with the Sun at about 15° of Libra and the comet near the beginning of Aries, almost in opposition to the Sun, the comet then, with a beard extremely sh-

[Margin: Ejus generis quidpiam in Cometâ anno 1580 obſervatum eſt.] *Something of this kind was observed in the comet of the year 1580.*

ort, was necessarily seen; hence they were not wrong to call that comet tiny. But a little later, when the comet had moved further from the opposition and was lingering in Aquarius and Capricorn, about the quadrature of the Sun, the tail was noticed to point more toward the region opposite the Sun, in accordance with our hypothesis above.

Therefore, just as, as you have seen, some comets near the opposition of the Sun, in a certain place in the sky, shine without a tail although in reality they possess a notable coma, so too I consider it by no means absurd that a comet may sometimes, in another position relative to the Sun (that is, outside the opposition), be seen entirely deprived of a tail; so that it is by no means necessary that all comets outside the opposition display a coma. But how, and when, does this happen, you now rightly ask? In our opinion a phenomenon of this kind comes into view whenever a comet consists of one single, dense and solid nucleus, which blocks the passage of all the Sun's rays, so that they cannot be carried through its head either by refraction or by reflection. Then, I say, it is quite fitting that no coma at all should meet the eye on the side opposite the Sun, until the more solid nucleus breaks up into several smaller parts and its matter is to some extent dissolved; notwithstanding that a sufficiently abundant, more dilute matter surrounded the comet, by whose help those rays of the Sun might conveniently be stopped.

[Margin: An Cometarum aliquis extra Oppoſitionem omni caudâ exutus quandoq́; appareat ?] *Whether any comet outside the opposition may sometimes appear stripped of all tail?*

Moreover, from however many parts the head of a comet may be composed, unless some thinner surrounding matter accompanies the comet to stop the Sun's rays, we wait in vain, believe me, for the comet's coma. But just as a comet is very rarely indeed born from only a single, extremely dense nucleus, and

hardly any is ever condensed without some more dilute matter accompanying it, so likewise one is very rarely seen outside the opposition entirely stripped of all hair. Nonetheless it has been shown that a similar phenomenon can sometimes arise in the aether.

[Margin: Deficiente materiâ tenuiori circaCometam, deficit quoq́; cauda.] *When the thinner matter around the comet is lacking, the tail is lacking too.*

From this foundation we also learn why new stars entirely lack tails. It is for this reason, I say: both because they consist of a single, more compact nucleus, and because these new [stars] are removed from the Earth by so immense a distance that, in comparison with it, the distance of the Sun almost vanishes. Hence, even if a tail really clings to the comet, none at all would be detected, as we have noted several times before.

[Margin: Cur novæ Stellæ nullas posſideant caudas?] *Why new stars have no tails.*

Since this is so, I do not see why the solar spots, which are composed for the most part of very diverse corpuscles and nuclei, and in addition of other, very thin matter set between them and surrounding them, should not equally display a tail or a coma. The chief reason is this: that the said solar spots never reach our sight except at the very conjunction with the Sun. There, although they doubtless really display a coma (these spots, that is, being born of diverse corpuscles), those tails are nevertheless by no means better perceived than those of comets at the very conjunction with the Sun (as we have likewise fully shown in its place), especially if the spots move about the centre of the Sun. But when they are near the horizon, at the sides of the solar disc, some trace of a tail does often cling to the spot. For those very wide tracts of more dilute matter, with respect to the centre

[Margin: Habent & Maculæ Solares, pariter ac Cometæ caudas ſuas reales.] *Solar spots too, like comets, have their own real tails.*

[Margin: Macularum Solarium caudæ in oppoſitum quoq́; Solis vergunt.] *The tails of solar spots also point opposite the Sun.*

of the Sun, always tending toward the opposite region of the sky, toward the periphery — namely those faculae and penumbrae, both primary and secondary — what else, I ask, are they but genuine tails of the solar spots? For it follows from this that near the rising these tracts of faculae and shadows always follow the spots, but near the setting they always precede them, in the manner of the tails of comets, which never fail to point toward the region opposite the Sun. But a spot moving in the very middle of the solar disc, at the very moment of conjunction with the Sun, nowhere stretches out a tail or coma to any side, nor puts forth a beard; but if it draws somewhat larger faculae and shadows along with it, the spot is surrounded by them and seems to stand, as it were, in their midst — in the same way as comets at conjunction appear within the tail itself, when they present a *Hircus*, or display a face shaggy on every side, as if surrounded by a dark cloud; of these, too, we have already treated above.

Therefore the solar spots too have real tails in their own way, even if these are not always equally conspicuous.

Lastly, to hasten to the end, it also concerns us to investigate whether the tails of comets, too, sometimes shine without heads, as heads do without tails, especially around the opposition of the Sun; and then how, when and where such a phenomenon arises. First, I flatly deny it: true tails of comets (if you except rods and meteors of that kind) nowhere rise without heads, much less come forth into view. For, as has been shown clearly enough, the head of the comet is the genuine source and only origin from which the tail can emanate away from the Sun [?]; but when the head is removed or lost, the tail perishes entirely, according to the well-worn saying: remove the cause and the effect is removed. Nevertheless I do not on that account entirely deny that a coma can sometimes be seen without a head. That is — so that you understand our meaning rightly — where there is a tail, there the comet's head must also be present; but with this difference: just as a head appears as if stripped of its coma, although in reality it spreads hair, in the same way, and in their own time, tails are produced whose heads are entirely hidden, or concealed with respect to us. This indeed happens around the conjunction with the Sun, when the heads are still lingering under the Sun's rays and display tails that are arched, winding, inclined not a little from the straight path, and indeed very long. At that time, I say, it can certainly happen that the tails of comets come into the light a little before sunrise or a little after sunset. With some of these, too — namely if they withdraw from the Sun by their own motion — the heads themselves sometimes emerge together with the tails after a certain lapse of time. On the contrary, if they are carried by their motion toward the Sun, or advance with equal velocity in the order of the signs, then, I say, only the tails, with the head cut off, shine continually until head and tail are actually dissolved and dispersed.

[Margin: An caudæ Cometarum etiam abſq; capitibus ſub adſpectum quandoq; veniant?] *Whether the tails of comets also sometimes come into view without heads?*

Some of those comets of which only the tails came forth have been recorded by authors; perhaps there were even more, but they were by no means noticed, because, no doubt, they were taken for meteors, or, because of a cloudy sky and adverse weather, did not come into view at all. For there is no doubt that, if tails of this kind are not endowed with singular brightness and breadth, they vanish at once in the twilight, whether morning or evening; especially

[Margin: Caudæ Cometarum abſq; capitibus obſervatæ.] *Tails of comets observed without heads.*

the weaker and shorter ones; so that they could by no means be noticed by the observers, the most curious of all and the more diligent. But the more recent tails stripped of their heads (as far as is established and has been committed to memory by writers) were those which the Erfurt History, on the Landgraves of Thuringia, mentions. But nothing more has been handed down about them than that three great, fiery tails of comets were seen near Eisenach; and it is to

be regretted that they did not leave us a fuller description of them. For it would have been worth the trouble to record whether they were very close to one another, or quite far apart from each other; besides, how long they lasted; and whether their heads too arose a little afterwards; and finally, with what aspect they shone: pointed, extended, arched, broad, compressed, very long, or rather very short.

In the year 1618, in the month of November, from the 18th up to the 20th, a little before that famous and celebrated comet arose about which we have said so much in this work, the tail of a singular comet was detected in various places in Europe: especially by the Fathers of the Society of Jesus at Rome; in Silesia by Joh. Remus Quietanus; at Danzig by Artus; and also at Linz by Kepler. For they report that a fiery tail appeared toward the east on the morning of November 11, like a somewhat arched beam. Joh. Strausius had written the following about this phenomenon from Tübingen, as may be read in the same author, p. 53, *De Cometis*: *That a meteor is rising with the stars in the Crater* (but they named this phenomenon so wrongly), *like a radiant little cloud, which at first had the form of a horn, [and] is now spreading itself more and more in breadth; and that on November 19/29 it was seen to be not of such redness as some days before, but to grow whiter, etc.* Kepler, however, expresses this still more clearly in the said little work, in these words: *On the morning of November 19/29, a Tuesday, at 5½^{h} after midnight, a very bright tract, full and milky, was seen just below the stars in the quadrilateral of the Raven, whose end curved upward, ending as it were in the middle of the Crater. That these were the rays of some comet was made credible by the following: that they came out of the dawn, and so stretched toward the part turned away from the Sun, as the hair of all comets usually does. For although the Sun was then at 28° of Scorpio, an arc of a great circle drawn from the middle of the Crater beneath the Beak of the Raven does not run to the ecliptic near the said place of the Sun, but toward the Altar, or rather the tail of Scorpio, and so deep into the south; yet that tract was not straight, but most manifestly curved like a scimitar, so that its lower part fell almost parallel to the last stars of Hydra, as if it were heading for the head of the Centaur, as appears from inspection of the globe. For the Centaur itself lay hidden in the dawn: by which path it would come very close to the Sun at 28° of Scorpio.*

[Margin: Anno 1618 pariter cauda Cometæ absq; capite deprehenſa.] *In the year 1618, likewise, the tail of a comet was detected without a head.*

And let this suffice about the tails of comets, since I seem to myself to have dealt fully enough with all the matters that I judged to bear on this subject. Now, as the sequence of this work leads us there, let us turn to the motion of comets. The more it has tormented all philosophers until now, the more effort must be spent to look more deeply into this rather obscure subject, and above all to investigate whether a circular motion belongs to each and every comet; or a rectilinear one; or indeed some other, whether regular or irregular. It will be worth the trouble to present this as proved and demonstrated not only by reasons but also by very many examples accurately recorded.

[Margin: Qualisnam motus competat Cometis, nunc diſquirendum erit.] *What kind of motion belongs to comets must now be investigated.*

End of Book VIII. [FINIS LIBRI VIII.]

Johannes Hevelius, Cometography, Book Nine [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER NONUS.]

On the Motion of Comets [De Cometarum Motu.]

Since, then, it is certain and settled that comets are entirely physical bodies, motion certainly belongs to them as well. For every physical body, according to all philosophers, claims some motion for itself. This is known not only from nature itself but also from the observations themselves. And first, indeed, in this respect (that is, in the view of those who assert the stability of the Earth): that they are carried by the common motion, and then that at the same time they exercise a definite proper motion. Neither the Peripatetic school nor Aristotle himself disputes this, namely that all comets are mobile. So too all history abundantly proves that they were at no time exempt from motion, yet in such a way that almost every one of them displayed a singular motion: for one was heading toward Favonius, another toward Subsolanus, another toward Notus, and another, finally, toward Aquilo.

[Margin: Cometas univerſos mobiles eſſe.] *That all comets are mobile.*

[Margin: Vnusquisq; Cometarum peculiarem motum exercet.] *Each of the comets exercises a motion of its own.*

All learned men, therefore, agree to a man that comets enjoy a proper motion. But is this proper motion irregular and wandering, and do the hairy stars, moreover, proceed along some tortuous line, as most of the Peripatetics assert? Or is it regular and proportioned in the highest degree, and also carried out under a nearly great circle? That case is indeed still before the judge. I therefore consider it worth the effort, since matters have come to this point, that the question be aired and examined as far as our powers allow.

[Margin: An motus Cometarum proprius regularis; an verò vagabundus ſit ?] *Whether the proper motion of comets is regular, or whether it is wandering.*

It will not, however, be laborious to settle this business, since we have already weighed this very question with ample care in Book III and clearly demonstrated that comets are so far from being subject to some irregular motion that they rather preserve, perpetually, the highest regularity in the very inequality of their motion, and always proceed under a nearly great circle; and with this let us rest content on this occasion too.

[Margin: Cometas ſub circulo propemodùm incedere maximo.] *That comets proceed under a nearly great circle.*

Since, therefore, it has been proved and demonstrated by evident examples and reasons that the bodies of comets move under some definite, nearly great circle, that motion can nevertheless be carried out in the most diverse manner:

namely in a circular or an elliptical line, or rather in a straight line, and indeed even in a parabolic one. For

[Margin: Stellæ crinitæ etiamſi ſub circulo ferantur maximo, posſunt tamen ſub diverſis lineis, tam circularib9,rectis,quàm conicis moveri.] *Hairy stars, even if they are carried under a great circle, can nevertheless move along diverse lines, circular and straight as well as conic.*

everything that really moves in a circle appears from afar to proceed in a straight line; and conversely, what advances in a straight line can in fact be carried in a circle, or an ellipse, or some other curved [line]: namely when the eye and the moving body lie in one and nearly the same plane, as is abundantly clear from the *Optics* of Aguilonius [François d'Aguilon], especially Book IV, prop. LVII, and also Book VI, prop. 10.

Hence arises among the philosophers that weighty and difficult question which has tormented them to the utmost until now: whether comets, even if they proceed under a nearly great circle and dwell in the very highest aether, are carried by a circular motion, by a straight one, or rather by some curved one? In my opinion, however, yet another question arises from this intermediate one: namely, if they are carried straight across, whether by their motion they describe a precisely straight line, or rather a line that is in some way curved or inflected. Further, if it is curved, whether it is regular or irregular; and finally, if regular, whether it is parabolic, elliptical, or rather hyperbolic? But of these matters more fully below.

[Margin: Quo autem motu univerſi procedant, haud vulgaris quæſtio eſt, inter Philoſophos.] *By what motion, however, all [comets] proceed is no ordinary question among the philosophers.*

To each of the two preceding opinions (for the others have scarcely yet entered anyone's mind until now) very many philosophers, ancient and more recent alike, adhere. Those according to whom comets move in a circular line or an ellipse hold at the same time that they are eternal bodies, like the planets and the fixed stars, but in diverse ways. Some assert that a comet is a single planet that appears rarely, as Hippocrates, Chius and Aeschylus, to say nothing of the rest; others believe it a body fused together from many diverse planets, as Anaxagoras and Democritus; others [hold comets to be] solitary wandering stars, as Diogenes, Apollonius Myndius, the Chaldeans and Seneca; others again that a comet is a heap of many small fixed stars. All of these, just as they place genuine comets in the heaven, so also count them among the eternal bodies, to which no motion is more fitting than the circular, or, according to certain younger [writers], the elliptical. To bring a rectilinear motion into the heaven, however, seems far too absurd to them, above all when it is considered that all the phenomena of comets can be explained more correctly and more successfully by circular motions.

[Margin: Variæ Philoſophorum opiniones, tam Veterum,quàm Recentiorum.] *Various opinions of the philosophers, ancient as well as more recent.*

But I by no means agree with this opinion, for the reasons now to be added. First: since every circular motion is continuous and perpetual, the bodies of comets, which for them are likewise eternal, ought therefore to return into sight at some time; but this by no means happens.

[Margin: Autor ab iis omnibus omninò diſſentit.] *The author disagrees entirely with all of them.*

For from all the comets that have been handed down to memory, however many, it is clearly evident that none of them has ever returned, nor has any other arisen that was similar in every respect to any one of those before it, whether as to colour, brightness, motion and size, or as to its tail. On the contrary, all the more recent ones, so far as it has been granted to judge, have appeared with an aspect altogether different from the more ancient ones, and different each time; whereas, according to the doctrine of those philosophers, they ought to complete fixed periods and so return at set times.

[Margin: Nullus Cometarum alter alteri ab omni parte planè ſimilis exiſtit.] *No comet is wholly similar to another in every respect.*

But you object: has any of the old comets been so exquisitely sketched and described by anyone that an accurate comparison of this kind could be made between the recent and the older comets, as indeed it rightly ought to be, and so that anything solid could be affirmed on this point? You will add that the orbit of certain comets is so large that such a haired star returns only after many centuries have elapsed; and that it is not at all necessary for it, in exactly the same place again, to re-

[Margin: Rationes pro motu Cometarum circulari.] *Reasons for a circular motion of comets.*

shine, but that it can certainly come forth in an altogether different region of the heaven, around different fixed stars. For it is by no means necessary that the centres of cometary orbits always lie within the system of the planets, nor that they have nodes fixed for all time; rather, at times they have definite translations of the nodes, on account of which it may happen that the earlier appearances are delayed not a little, are advanced, and are transferred to one quite different place of the heaven after another?

These reasons, however, though they may seem to carry some weight, can nevertheless easily be refuted, namely by denying and demonstrating that comets are by no means eternal bodies. Once that is done, the whole foundation of that opinion will collapse from the ground up, and there will no longer be any room for the motion to be established as circular in this way. This is above all because, as far as I can grasp with my mind, every single phenomenon is saved more correctly and more readily by a nearly straight motion, as I shall demonstrate more fully below.

[Margin: Si quis neget, Cometas corpora eſſe æterna, de omnibus iſtis rationibus actum eſt.] *If anyone denies that comets are eternal bodies, all those reasons are finished.*

Every one of the more recent writers does indeed labour to show from the observations of Cysat that the head of the comet of the year 1618 was composed of very tiny fixed stars; but in truth this is in no way drawn out of that observation.

[Margin: Ex Cyſato minimè deducitur,corpora Cometarum ex Fixis esſe congeſta; multò minùs æterna.] *It is by no means deduced from Cysat that the bodies of comets are heaped together from fixed stars, much less that they are eternal.*

And yet I do not deny that Cysat noticed that the said comet was heaped together from very tiny corpuscles which bore, it is true, the appearance of very small fixed stars; but by no means [that it was made] of the fixed stars themselves, much less that it was a firm and stable continuous body, as much in substance as in true size, shape and colour. Rather, [he noticed] that they were corpuscles illuminated by the Sun, of diverse size and of irregular shape, of which some successively grew and others diminished, and which also changed their form and position, and in the end perished altogether, as is evident enough from Cysat, Chap. VIII. For he asserts first: *that a comet is a heap or confluence of many bodies, which receive light when the Sun shines upon them, and shine like little stars*; they were by no means, he says, fixed stars, nor planets, but twinkled like little stars; and he explains his meaning still more clearly in the same chapter, paragraph 4.

[Margin: Quid reverà ſentiat de corporibus Cometarum Cyſatus.] *What Cysat really thinks about the bodies of comets.*

But I would not say that these luminous bodies which constitute the head of the comet are stars in such a way that they must therefore necessarily be of perpetual duration, like the stars of the firmament and the common planets; rather, I say that they are of the same matter, origin and nature as the solar spots, which are themselves also wandering stars around the Sun, inasmuch as they would appear to us to shine if they could ever rise heliacally for us.

For the rest, if those bodies of which the head of the comet consists were fixed stars, they would certainly also display an exquisitely spherical shape, just as the other fixed stars [Affixæ] do; and they would also always keep the same size, apart from that variation which arises from their differing distance from the Earth.

[Margin: Cometas neutiquam ex Stellis Fixis conſtare.] *That comets by no means consist of fixed stars.*

These corpuscles, however, are not always of perfect roundness; rather, most of them are many-angled in many ways and irregular in shape, like the solar spots, which now grow and now diminish. Often they appear larger at a farther elongation from the Earth, and again smaller at a nearer distance; now they become thinner, now more solid and compact: things that are by no means observed in the fixed stars. Above all, if [it] were a heap of little stars and an eternal body, would it not always present entirely the same face and shape? Except that around the last appearance, when they withdrew from sight, they would be seen only a little smaller, according to appearance. This, too, willingly

I grant: namely, that all comets in this way (unless they set heliacally, or are carried toward the Antarctic pole, that is, to the stars of perpetual occultation) successively decrease more and more in proportion to their greater distance from the Earth; but only as far as sight is concerned, which you should note well. For, as both observations attest, Cysat's made in the year 1618 as well as ours made in the year 1652, the head of each comet was at the beginning far smaller than it was at the end, around its disappearance, although it appeared otherwise to the unaided eye; as we showed fully enough in Book VI.

[Margin: Capita Cometarum 1618 & 1652 longè reverà majora ſub finē, quàm initiò apparitionis extiterunt.] *The heads of the comets of 1618 and 1652 were in fact far larger toward the end than at the beginning of their appearance.*

For the apparent diameter of the comet of the year 1618 was observed on December 1 as 8′, from which its true [diameter] comes out by calculation as 144 German miles; but on December 29 the apparent diameter was found to be 16′, so that the true [diameter] was then 1000 miles and more. The same happened with the comet of the year 1652. Its apparent diameter at the beginning of its appearance, on December 20, was observed as 30′, and so its true diameter stood at 825 miles; again, toward its end, namely on January 8 of the following year, although the apparent diameter was found to be only 4′ 40″, the true one nevertheless amounted to 12000 miles, as may be read more fully in the book just cited, p. 337, to which I refer the reader.

[Margin: Vera diameter utriuſq; Cometæ quanta extiterit ?] *How large the true diameter of each comet was.*

The reason for this phenomenon, moreover, is this: that around their last appearance comets appear not only smaller but also paler; and this pallor derives not so much from the greater distance as from the rarity and thinness of the matter. For over the course of a longer time those corpuscles which make up the head of the comet are more and more pulled apart, dissolved, thinned and scattered. Hence at that time the head both grows pale and, by reason of the dispersed corpuscles, actually grows in diameter, although to the naked eye it is judged to decrease a great deal, as the calculation confirms.

[Margin: Cur circa disparitionem appareant minores & pallidiores ?] *Why do they appear smaller and paler around their disappearance?*

Since, therefore, comets are first born from the thinnest matter and the smallest corpuscles, and successively grow into a great mass, then gradually dissolve again, and are finally reduced into the subtlest ethereal matter, as we set out at length in Book VII, comets are therefore by no means perpetual bodies, but rather temporary ones. To assign a continuous and perpetual motion to them, however, seems far too absurd, nor does sound reason recommend it: namely, that perishable bodies should move perpetually in a circle or an ellipse, just like the planets, which are perfect and eternal ethereal bodies, exercising a motion that is never other than continuous and perpetual.

[Margin: Cometæ ſunt corpora temporanea, quibus motus perpetu9 haud convenit.] *Comets are temporary bodies, to which perpetual motion is not fitting.*

Comets, by contrast, are only imperfect ethereal bodies, and temporary ones at that, which are generated and dissolved at a definite time, and never complete a whole circle by their motion.

[Margin: Cometæ ſunt corpora ætherea imperfecta.] *Comets are imperfect ethereal bodies.*

Therefore they possess no continuous or perpetual motion. Rather, everyone will acknowledge with me that it is more fitting and suitable to attribute a straight motion, which is likewise finite and determinate, to those perishable bodies that arise and pass away, that have an end, and that are no longer in their natural place but are set outside it: for everlasting things revolve in an orbit, but things destined to perish pass across in straight lines.

[Margin: Quinam motus ejusmodi corporibus competat ?] *What motion befits bodies of this kind?*

[Margin: Corpora æterna volvũtur in orbem; caduca verò rectis lineis feruntur.] *Eternal bodies revolve in an orbit, but perishable ones are carried in straight lines.*

But a doubt remains which could keep our opponents anxious: namely, that if we establish that the bodies of comets are always carried in straight lines, we must certainly suppose the world to be infinite. But surely by no means, unless at the same time you imagine that the bodies of comets are eternal, without physical rising and setting: to which bod-

[Margin: Si Cometis motus detur rect9, an ideo Mun dus ſit infinit9?] *If a straight motion is granted to comets, is the world therefore infinite?*

ies, I willingly grant, it is not consistent to ascribe a continuous and perpetual motion in a straight line, since they would tend to infinity; and that, however, can never happen, as Aristotle himself also plainly demonstrates in the *Physics*, Book VIII, Chapter 8.

However, the Peripatetics object: if straight motion is granted to comets, they must necessarily also be in the air, and consequently also of an elementary nature. For only straight motion belongs to elementary bodies, as to the elements themselves, but not to ethereal ones. The major [premise] of this argument, namely that whatever is carried with straight motion consists of the elements, I would readily concede, since nothing else is drawn from it than that they consist of elementary matter, if, that is, they proceed with straight motion. But this certainly does not stand against us in the least. For we freely concede, following a great many philosophers, that the celestial bodies, and indeed the planets themselves, consist not of some fifth essence but of the elements themselves, as our Earth does, though in their own way, and of a far subtler matter. Since it has been demonstrated that generations and corruptions occur in the ether from various effluvia and expirations just as in the aerial region, this argument hence fights rather on our side. For once it is demonstrated that comets are carried across with straight motion, it must also be conceded that the ethereal bodies are of an elementary nature. But there is no point in saying anything more about these rather trivial matters.

[Margin: Num propter motum rectilineum Cometæ verſentur in aëre ?] *Do comets dwell in the air because of their rectilinear motion?*

[Margin: Cometas conſtare ex materiâ elementari, Autor facile largitur.] *The author readily grants that comets consist of elementary matter.*

Let us look at the second argument, by which our opponents strive to destroy straight motion in the heavens and in comets. It has, namely, been detected in some hairy stars, especially the one that shone in the year 1618, as is clear from p. 119 of Book I, that a little before they disappeared entirely they did not proceed so precisely in a great circle in their last appearances, but deviated somewhat from that straight path; as likewise happened with the comet of the year 1652. For the angle between the comet's orbit and the ecliptic, and also the equator, was observed to be different in its more advanced age from what it was when the comet was still fresh from its rising. From this they try to establish that comets did not describe a great circle quite so precisely, and so do not persist in a straight course at all. For a straight line at an infinite distance is always projected into a straight line, and is in no way found to curve, as Optics demonstrates. But since comets stray somewhat from an exact straight line, it follows that they move rather in a circle or an ellipse.

[Margin: Argumentum contra motum rectum à variatione anguli Orbitæ & Æquat. depromtum.] *An argument against straight motion, drawn from the variation of the angle of the orbit and the equator.*

First, it cannot be denied that a great many haired stars, indeed all of them (in my opinion, at least), deviate toward the end of their appearance from the straight [line] along which they proceed, as soon as they slacken a little from their faster course, decrease, thin out and grow pale. Examples are at hand both in the comet of the year 1618 [and that of] 1652, and also in three others cited in Section 10 of Book I. And so that you may have all those deviations at a single glance, or rather the angles of each comet's orbit and the ecliptic, and likewise the variation of the node, I have chosen to present this little table to you.[589]

In what year they appeared	Duration in days	Variation of the angle of the orbit and the ecliptic	Variation of the node
1577	74	0° 9′	0° 4′
1585	28	1° 52′	0° 22′
1590	14	0° 4′	0° 40′
1618	21	1° 23′	1° 0′
1652	15	1° 4′	0° 34′

[Margin: Omnes Cometæ circa ultimam apparitionem à rectá lineâ nonnihil deflectunt.] *All comets deflect somewhat from a straight line around their last appearance.*

[589] On the page the table stands in a ruled frame at the right of the last seven lines of the paragraph above, with no caption. Its third and fourth columns each print a degrees figure and a minutes figure under the heads Grad. Min. and Gr.M.; each pair is set here as one value.

[Margin: NonnulliCometæ in quantum à recto tramite deviaverint.] *How far some comets have deviated from the straight path.*

Since, then, the angle between the orbit and the ecliptic varies by one or two degrees, you will say: how, I ask, do comets proceed under an exactly great circle? Yet it by no means follows that for this reason comets are carried not in a straight line at all, but in a circle. For this deviation sometimes arises from the fact that comets do not always keep the same distance, both from the Sun and from the Earth; and from this the said angle varies in every way, as usually happens with the superior and inferior planets, and as we also amply demonstrated in Book I. For as to an ethereal body: when it hangs close over the Earth or the Sun, the angle of inclination grows; and again, when it is farther away, it decreases, especially when the motion of the Sun, or of the Earth, supervenes; as is evident from the comets of the years 1585, 1590 and 1618.

[Margin: Ratio, cur angulus iſte Orbitæ varietur ?] *The reason why this angle of the orbit varies?*

Besides this, however, there must still be another reason underlying it, on account of which this angle varies in some comets. We are led to this by the fact that in the comets of the years 1577 and 1652 the angle between the orbit and the ecliptic increased from day to day, as was shown in Book I, Section X, although with the passage of time each of them moved farther and farther from the Earth, so that by that former reason it would rather have decreased. But I presume the genuine cause of this to be that there is a certain true deviation, and by no means an apparent one, which is noticed around the dissolution of comets. And it flows from this: that those bodies, and the matter of which a comet consists, hardly ever move away from the centre of the disc equally and uniformly and are dispersed on every side; but that, in accordance with the nature of the matter and the motion impressed on it from the beginning, that matter is dissolved more and more, now from this side of the disc, now from that, and the deviation always inclines toward the direction in which it is carried by its first impetus.

[Margin: Variatio anguli Orbitæ & Æquat., alia eſt apparens, alia realis.] *Of the variation of the angle of the orbit and the equator, one kind is apparent, another real.*

But so that you may grasp the matter more correctly, I must here briefly recall to your mind what we said in Book VII about the birth and dissolution of comets: namely, that a comet is born from the joining and condensation of a certain most subtle celestial matter, from which bodies or nuclei are successively generated. But I would have you know that this aggregation, compaction and accretion of matter cannot take place entirely equally and uniformly with respect to the centre; rather, it is more likely that more matter comes and adheres without any fixed law, now on this part of the body, now on that. Because of this, the centre of that matter of the new cometic body is actually transferred to one place after another. And hence a certain slight deviation arises around the comet's first birth, even though it is carried across in an entirely straight line.

But afterwards, once the matter has gradually condensed and matured and the nuclei and bodies have grown, that whole new cometic body is girded, as it were, by a bounded rim; and although it is very rarely of a perfectly spherical shape, that body or disc nonetheless appears nearly round, so that a definite centre can be marked by observers. From this it comes about that, while the comet persists in its state or vigour, until it begins to decrease and its matter to be thinned and dissolved, either a very slight deviation from the straight path, or none at all, can be noticed in the comet; that is, the angle of inclination between the orbit and the ecliptic remains the same to such an extent that hardly any difference at all is detected.

[Margin: MateriaCometica, ratione centri, non aggregatur uniformiter ab omni parte.] *Cometic matter is not aggregated uniformly on every side with respect to the centre.*

[Margin: Vnde deviatio Cometæ realis exoriatur ?] *From what does a comet's real deviation arise?*

[Margin: Quo tempore vix ſenſibilis aliqua in Cometis deprehendatur deviatio.] *At what time hardly any perceptible deviation is detected in comets.*

Hence the greatest deviation always occurs around a comet's first birth, when the matter is first gathered together and flows in. But as the body becomes more and more compacted, that deviation decreases and approaches the straight [line] more and more. For, as you have just perceived, the more mature a comet is, the more closely its matter coheres; and with a firmer body its figure and form change less, and its centre is shifted and shaken more sluggishly.

[Margin: Et quando vicisſim maxima ?] *And when, in turn, is it greatest?*

The reason is indeed the same in the corruption and dissipation of a comet. For after it has reached maturity and has persisted in it for some time (according to the constitution of its body and the tenacity of its matter), it decreases again, and its matter is dissolved, disaggregated and dissipated; but not entirely evenly on every side of its body, or from the centre of the disc; nor do the bodies or nuclei move away from one another uniformly. Rather, by reason of the matter: the more it inclines toward dissolution on this part of the body or that, the more the inclination also tends toward that quarter, and as it were moves the centre away. Therefore, as the dissolution and disaggregation of the matters and bodies ensues, a certain deviation from the straight path arises, which increases the more, the more the comet hastens toward its dissolution and the matter is dilated. Yet not all [comets] always show the same deviation; rather, in accordance with the motion of disaggregation and dissipation, it is observed in some now greater, now smaller, to the extent of one or two degrees.

[Margin: Decreſcente Cometâ, deviatio ſeu inclinatio augetur.] *As the comet decreases, the deviation or inclination increases.*

[Margin: Non tamen in omnibus pari ratione.] *Yet not in the same measure in all.*

But you ask why this deviation is not detected equally, and the same, around a comet's first rising as around its setting? I will tell you. It cannot indeed be denied that no deviation at all has been noticed around the first appearance in any comet whatever, much less that this exorbitation grew at the beginning and decreased again at the end, as we have learned from the examples of all comets whatever. But you must know that this has come about for no other reason than that the first birth of a comet, and the fresh condensation and aggregation of its matters, almost never meets the eye. For since every comet is always kindled in the heavens unexpectedly, while we are expecting nothing of the kind (nor do we know in advance the place where that phenomenon is to burst forth), it certainly cannot happen otherwise than that we catch sight of it and observe it later than expected. On the contrary, it mostly happens, indeed hardly ever otherwise, that we first lie in wait for comets with instruments only when they already stand in the fullest flower of their age, or in their best state and vigour; at that time the angle between the orbit and the ecliptic, or the equator, varies very little, indeed almost not at all, until [the comet] in turn verges toward its dissolution, when the deviation first strikes the senses, for the reasons given above. But once comets have come into the sight of all, we spend every effort to follow them with our eyes for as long as possible, as long as any trace of it remains. This, too, succeeds much more happily when we know its true place in the heavens, where it appears; but if that is unknown, it is useless to search for it among so many fixed stars, much less to make it out. The daytime observations of Venus bear this out all too clearly: for if you do not know the place of Venus, you will detect her by day only with great difficulty, indeed hardly by chance; whereas for someone not ignorant of her tracks, just as she is easy to track down at any time, even with the Sun very high, so indeed for as long as pos-

[Margin: An circa Cometæ exortum, ejusq́; interitum eadem omnino dctur deviatio ?] *Is altogether the same deviation found around a comet's rising and around its dissolution?*

[Margin: Prima Cometarum nativitas vix unquã obſervari poteſt.] *The first birth of comets can hardly ever be observed.*

[Margin: Comet.e tum primùm in conſpectum plerunquè veniunt, quando jam in ſummo flore exiſtunt.] *Comets for the most part first come into view only when they are already in their fullest flower.*

[Margin: Deviatio multò notabilior eſt in fine, quàm initiò apparitionis Cometarum.] *The deviation is much more noticeable at the end of the appearance of comets than at its beginning.*

sible anyone then keeps hold of her and observes her. It is therefore certain and beyond doubt that comets are noticed for longer around their end, but later around their beginning; and that in this way, too, a more noticeable deviation can be detected at their exit than at their rising.

Meanwhile, however, I am thoroughly convinced that if we caught sight of a comet straight away in its first age, the deviation would always be far greater

than in its more advanced [age], when it already holds its highest strength. But there is no reason for you to think that this deviation grows and decreases in the same way and entirely equally, since the manner and mode of the coagulation of the matter and of the generation of the bodies around the rising may be very different from those of their dissolution and dissipation around their end.

[Margin: An deviatio æqualiter ſemper creſcat & decreſcat ?] *Does the deviation always grow and decrease equally?*

We notice something similar in our clouds. For when, as sometimes happens, one very large cloud coalesces from a great many very thin little clouds scattered here and there, it very rarely happens that all the rest fly together to that one uniformly from every side; rather, they adhere more abundantly now to that side, now to this. For this reason the course of that cloud, even though it is set going by a rather strong wind and driven in a straight line, is in no way as straight, with respect to the centre of the whole mass, as when that cloud has already attained its full consistency and size. The case is the same in the dissolution of that cloud: for larger little portions usually depart from it on this side than on that, so that it at length turns aside a little from the straight route it first took, and from this a certain deviation arises.

[Margin: Nubibus res declaratur.] *The matter is illustrated by clouds.*

From javelins, arrows and meteors of that kind, which observe a similar straight passage, we prove the same: namely, that at the beginning their motion, as far as one may gather, is nearly straight; but afterwards, when they dissolve, they go off here and there in different directions, straying from the straight path they had taken up. But best of all, all these things that have been said can be elucidated and demonstrated from the birth and dissolution, and the motion, of the solar spots. For nothing ever agrees more with comets, and nothing is joined to them by so close a bond, as those spots, as we have already shown at length in Book VII. For in the first rising of the faculae and spots we clearly detect that the first, more diluted matter, especially around the faculae (the seeds, as it were, of the spots), is not gathered and coagulated entirely equally with respect to the centre. And hence at the beginning, usually, before the spots reach a mature age, the variation and libration of the centres is indeed much more evident at that time. But once they have been brought to maturity, they do not stray even a tiny bit from the course of their path, granted by nature and once entered upon, and they press on vigorously until they are again dissolved into faculae and the thinnest matter and shadow; from that time, I say, the centre in turn wanders off and brings about a quite evident deviation, since the matter of the faculae is more prone to dissolution and separation on one part of the disc after another. This is easy to confirm from almost countless examples of faculae and spots, and especially from those spots, generated and destroyed in the hemisphere of the Sun that lies open to us, that were observed both by Scheiner and by us: for instance, the spot *a* in Figure XVI, p. 545; the spot *d*, Figure XVIII, p. 517 of the *Selenographia*. Likewise from the image of observations 44, p. 268:

[Margin: Jacula, & Sagittæ idem probant.] *Javelins and arrows prove the same.*

[Margin: Ex Maculis verò, & Faculis res eadem adhuc clariùs demonſtratur.] *But from the spots and faculae the same thing is demonstrated still more clearly.*

[Margin: De centrorum libratione Macularum Solarium, & earum deviatione à ſemel ſuſcepto tramite.] *On the libration of the centres of the solar spots, and their deviation from the path once taken up.*

image 54, p. 29, and 55, p. 292, inserted in the *Rosa Ursina*, and very many others. These are clear proof that the matter of the spots and faculae, around their birth and dissolution, while it flies together and is condensed, [and] again separates and is thinned out, deviates not slightly from its natural path or course; and that it hardly ever keeps to its course as constantly at the beginning and the end, with a body, namely, more diluted and more dispersed, as in the middle, with one in some measure more compacted.

Yet, with no account taken of this deviation, even though a quite notable one is present in the spots, it is nevertheless commonly accepted, when this matter is discussed, that they do not bend their path at all but go strictly straight on. We also speak of comets in this way: even though a similar deviation is detected in them, especially in those worn out with old age, one that arises, namely, from a particular motion of the parts and corpuscles, we nevertheless merely assert, without qualification, that comets are carried across in a straight line.

[Margin: Motus iſte Cometarum rectilineus non absquè aliquali deflexione accipiendus eſt.] *This rectilinear motion of comets is to be understood as not without some deflection.*

In sum, so that you grasp the matter rightly, the deviation of comets arises from a twofold cause. And one is apparent, the other true and real. The former takes its origin from the varying position and varying distance of comets from the Earth and the Sun, and from the annual motion of the Earth; the latter from the matter of their bodies and nuclei, which does not grow and decrease uniformly on every side. Both departures [exorbitantia] are indeed common to all comets; yet in individual comets they are hardly, and rarely, discerned together.

[Margin: Non in omnibus Cometis, vera & apparens deviatio ſimul ſemper deprehenditur.] *Not in every comet are the true and the apparent deviation always detected together.*

In the more distant comets, which are made up either of one single nucleus or at least of fewer nuclei and are furnished with a small head; which, moreover, remain somewhat longer in their vigour and steady state, and in addition decrease slowly, yet truly, before they escape everyone's eyes because of its too great distance from the Earth, as in the example of the comet of the year 1618: in those, I say, only that deviation is detectable which arises from the motion of the Earth and the varying elongation of the comet relative to the Earth and the Sun; and it decreases continually in appearance, namely as the distance from the Earth increases. But the other departure, even though it is present in the same

comet together and at the same time, hardly strikes the senses then, because of the comet's too great remoteness and the slenderness of its body.

[Margin: In quibus Cometis deviatio apparens ſit deprehenſibilis; altera verò realis rursùs inſenſibilis.] *In which comets the apparent deviation is detectable, while the other, the real one, is in turn imperceptible.*

But in the nearer and larger comets, which have arisen and been fused together successively out of abundant matter and innumerable bodies and nuclei, and which are engaged in a perpetual motion of alteration, and which undergo a very evident change as regards their matter and nuclei before they are raised too far from us: in these, I say, not only the apparent but also the true deviation is clearly noticed. If the true one is greater than the apparent one, it absorbs the other almost entirely. Which of these prevails over the other is recognized by the following rules. When the deviation decreases at the beginning, up to the comet's maturity, and thereafter increases again up to its exit, the true departure stands out: as in the comets of the years 1577 and 1652. But when the deviation increases at the beginning and in turn decreases at the end, the apparent one, arising from the varying position of the comet relative to the Earth and the Sun, prevails, while that other, true one is silent in the meantime; with this express condition, however, that you suppose the comet to be far distant from us at the beginning, very near the Earth in the middle of its path, and thereafter, successively, more remote again; otherwise the matter would certainly turn out differently, as anyone who weighs this business somewhat more deeply easily understands. This deserves to be noted, since the reasons for this phenomenon have so far been discovered by no one. But above all I would have you take good care lest those deviations, inclinations and curva-

[Margin: In quibus apparens & realis deflexio ſimul deprehendatur.] *In which [comets] the apparent and the real deflection are detected together.*

[Margin: Altera alteram nonnunquam eliminat.] *The one sometimes eliminates the other.*

[Margin: Certæ regulæ, ex quibus dignoſcitur, utrûm prævaleat deviatio realis, an apparens ?] *Fixed rules by which it is discerned whether the real or the apparent deviation prevails.*

tures be confused. For the deviations of the heads, which we have just been discussing, are one thing; the deviations and inclinations of the tails, which we treated fully in Book VIII, are something else entirely.

[Margin: Deviationes capitum Cometarum à deviationibus caudarum benè diſcernendas eſſe.] *The deviations of the heads of comets must be carefully distinguished from the deviations of the tails.*

So nothing more remains than for me to recall to your memory once more that the deviation of the tails almost never keeps equal degrees of increase and decrease, but not rarely is changed completely, namely passing from southern to northern, and vice versa. By contrast, this deviation, which we have discussed in this Book, for the most part increases and decreases steadily, as far, that is, as

one may gather from those very few comets so far properly observed. That is: whatever comet, after it has attained its greatest strength, begins to be dissipated and its deviation to increase, its deviation never decreases again; and vice versa. Although, as I suspect, the contrary may also happen to some other comets.

[Margin: Deflexio caudæ non æqualiter perpetuò creſcit & decreſcit.] *The deflection of the tail does not grow and decrease evenly throughout.*

Finally, yet another, different cause presents itself, on account of which a certain definite deviation from the straight path can occur in comets, around the beginning as well as the end: namely by reason of the impressed motion; and then also by reason of the inclination of the cometary disc toward the Sun. Since these are very subtle and lofty speculations, touched on by no one so far as I know, and since moreover they demand many things known beforehand, we must refrain on this occasion from treating them thoroughly, until we have first shown from where the motion of comets, or their first impetus, takes its origin; and what it is that impresses motion on comets, and indeed a nearly straight one;

[Margin: Quomodo Cometæ etiam ex motu impreſſo, & inclinatione diſci Cometalis nonnihil exorbitent.] *How comets also stray somewhat because of the impressed motion and the inclination of the cometary disc.*

But so that we do not linger over these matters any longer, since in our own opinion we have already been rather long-winded, we must return once more to the motion. And so I think that what we touched on lightly above should be recalled at the outset: namely, that I firmly hold that no comet is moved circularly by its proper motion, but that it is carried across in a nearly straight line; yet in such a way that sometimes, at the first rising of the comet, when that body first begins to be generated and condensed (which, however, hardly ever comes into our view), and again at its last appearance, it strays not a little from the straight track of its path, not only apparently but also truly: for reasons partly already put forward, partly still to be put forward. In our view, therefore, comets enjoy this single, nearly straight motion. For that other motion, by which all of them, each and every one, appear to be carried uniformly from east to west, and which the Peripatetics ascribe to the primum mobile but we more correctly to the diurnal motion of the Earth, by virtue of which both the comets and all the stars return, rise and set each day, namely in the space of twenty-four hours, has no place here, nor anything to do with the proper motion of comets, as long, that is, as we are considering the true motion. With regard to the apparent motion, however, this diurnal and annual motion brings about many peculiar phenomena; but of these we will have to speak more fully in their proper place.

[Margin: Ex Autoris ſententiâ, Cometæ motu propemodùm recto progrediuntur.] *In the author's view, comets advance with a nearly straight motion.*

[Margin: Feruntur quidem ſimul etiã motu communi, ſeu diurno; ſed cum iſto apparente hàc vice nihil habemus negotii.] *They are indeed also carried at*

the same time by the common, or diurnal, motion; but with that apparent motion we have nothing to do on this occasion.

Now let us see: why does a straight rather than a circular motion belong to comets? First: I do not deny that to all the bodies of the world that are contained in the embrace of the heavens only a circular motion, or more correctly an elliptical one, belongs as natural to them; but, as I would have you note well, as regards

[Margin: Quare Cometis omnibus motus rectilineus, quàm circularis magis conveniat ?] *Why does a rectilinear motion suit all comets better than a circular one?*

the whole, and as long as that body remains in its natural place and in its unity. But when some body is moved from its natural place, or is thrust out of it, whether by an intrinsic or an extrinsic cause, and so is outside its place: then, I say, no motion belongs to that body except a straight one, or at least one that, because of certain obstacles, comes close to a straight one. Moreover, to perfect and eternal ethereal bodies, such as the planets, only motion in an orb is rightly attributed, namely the motion that alone is continuous and eternal. But to imperfect, temporary ethereal bodies, which arise and perish, such as comets, bodies that are separated from their whole as parts and that abandon its unity (as Copernicus, a man of admirable sagacity, rightly and aptly says in Book I, Chapter VIII of the *Revolutions*): to these, I say, straight motion is better suited; and our Earth fully confirms this. For the Earth, as regards the whole, set in its natural place by God, Best and Greatest [DEO O. M.], as a perfect body, is subject to no rectilinear motion, but only to an orbital one, if any local [motion] has to be assigned to the whole body. But terrestrial parts, removed or torn away from their whole, and yet not impeded, have no motion other than a straight one (in which there inheres a force, so that all worldly things are able to preserve themselves); namely from a defect, because they are situated outside their place and these particles lack a natural place: and hence, by a certain unavoidable necessity, they are moved in no way except in a straight line.

[Margin: Quibus corporibus motus rectus,& quibusnam vicisſim circularis ſeu Ellipticus competat ?] *To which bodies does straight motion belong, and to which, in turn, circular or elliptical [motion]?*

Since, therefore, comets, to speak still more plainly, are ethereal bodies, produced from the effluvia, evaporations and exhalations of the planets, and indeed for the most part of several different ones; since they are generated and destroyed in their own time; since, moreover, they are only parts or exhalations of the other ethereal bodies, the planets, which are thrust out and expelled from their natural place, namely the planets, by a certain force implanted by nature; and since, further, a natural place is lacking to them any longer: these comets are driven by no other motion than a rectilinear one, as bodies imperfect according to nature, temporary, and parts separated from their whole and set outside their natural place; and, further, as things not in their right condition.

[Margin: Cur Sidera Crinita alio motu quàm recto ferri nequeant ?] *Why can hairy stars not be carried by any motion other than a straight one?*

Furthermore, just as for spherical bodies, once imbued with circular motion, no other motion in which they can continually preserve themselves suits them better than the orbital motion itself; so, conversely, the other, flat-shaped bodies, whether they are round, oblong or angular, utterly scorn and reject that motion in an orb, even if the said circular motion is deliberately impressed on them at the outset: those bodies, that is, which are carried with their face and disc erect, or with their flat surface toward the centre of the circle along which they travel. And this is for the following reason: that spherical bodies have all round them parts that are equal and equidistant with respect to the centre of their body, none of which projects beyond the rest. Therefore nothing whatever can resist this motion in an orb, once set going, any more than the other, straight one (if [the body] had received its impetus at the outset in accordance with this motion), so as to keep it from continuing its own [motion] without pause. For the leading part of a spherical body, just like the following part, becomes neither sharper nor blunter as it goes, but always remains the same; so that no hindrance is put in the way of these bodies by the turning, or circular inclination, since their shapes are spherical and equal on every side.

[Margin: Quare corpora ſphærica ſemel in orbem acta, indefinenter motum iſtum circularem proſequantur?] *Why do spherical bodies, once set going in an orb, pursue that circular motion without ceasing?*

But indeed the matter stands far otherwise with flat-shaped or disc-shaped bodies, whether they present a round, an oblong or any other figure whatever: namely when they move with their flat face erect, always presenting their disc toward the centre, but by no means toward the plane of the circle in which they are carried. For even if a circular motion is impressed on bodies of that kind at the beginning with the greatest effort and the greatest force, they would nevertheless in no way preserve that motion perpetually, even though the impressed impetus were continuous. At the start, indeed, they would proceed along an orbital course with an almost violent motion; but as they advanced successively they would gradually fall away from that circular path, inclining more and more toward a straight line: so that the motion would by no means be circular from the very threshold, but would represent the half-section of a parabola or of a hyperbola; in such a way, namely, that the line described, more curved at the outset (as at the vertex of the conic sections), would thereafter become gradually straighter, until at last the motion of that disc-shaped, or flat-shaped, body degenerated into an entirely straight line: as usually happens in conic sections.

[Margin: Quomodo corpora diſcea, licet motus orbicus eis imprimatur, nullâ tamen ratione eundem conſervare posſint; ſed ſenſim in rectam, ſeu potiùs ſectionem aliquam conicam degenerent.] *How disc-shaped bodies, although an orbital motion is impressed on them, can nevertheless in no way preserve it, but gradually degenerate into a straight [line], or rather into some conic section.*

The reason is this: that a disc-shaped body of this kind, whether it is like an orb, or of lenticular form, or like any angular [figure] whatever (it makes no difference), does not have parts around its centre in every direction, as a spherical body does, either as many or as equal. From this, if you cut out a spherical and entirely globular body, as large as it can possibly be, at the centre of that disc-shaped body, two large portions must necessarily remain beyond that globular body, projecting considerably, according to the breadth and width, or depth, of each disc-shaped body so cut down. These flat-shaped parts hinder and hold back [the body], so that such a body as a whole, even though it has received an impetus for continuing an orbital motion, nevertheless cannot advance continually in an orb, but inclines rather toward a straight path, which it traverses more readily. For such is the ordinance of nature, that bodies are moved by the motion by which they can be moved more easily. Accordingly, disc-shaped bodies of this kind, of whatever thickness they may be, provided only that they are not equally thick on every side, that is, [not] spherical, pass across in a straight line at once, as soon as they acquire a straight impetus, namely for as long as that impressed motion lasts; and they are stopped and checked by nothing else supervening, whether violent from outside or from within. Indeed, these bodies proceed continually straight on so precisely (insofar as they are not constrained by another cause, as I was saying just now) that they do not deviate in any way toward this or that region, even in the slightest.

[Margin: Quid obſtet, quòd corpora diſciformia in orbem continuò moveri nequeant. Et quare ad motum rectum magis propendeant ?] *What prevents disc-shaped bodies from being able to move continually in an orb. And why do they incline more toward straight motion?*

[Margin: Omne corpus eo movetur motu, quo procliviùs moveri poteſt.] *Every body is moved by the motion by which it can be moved more readily.*

All these things that have been said, however firm the footing on which they stand, are nevertheless not grasped so readily and thoroughly by everyone. Let us therefore go very shortly to elucidate them more clearly and demonstrate them more plainly, provided that we have first compared all of this with the comets. Since the matter is a very difficult one, on which almost the whole business of the straight motion of comets depends, and from whose demonstration it is plainly revealed why hairy stars universally, once their bodies are condensed, are carried in no orb but never otherwise than in a nearly straight line, until they flow apart and dissolve?

[Margin: Ex his rectè demonſtratis, ratio patet, cur Cometæ rectà fere trajiciantur?] *From what has been rightly demonstrated here, the reason is clear why comets are carried across in a nearly straight line?*

Now, since the heads of comets are by no means spherical bodies, but flat-shaped ones, like orbs and clouds, or extended bodies: as [in] Book VI

[Margin: Cometæ tanquam corpora diſcea reſpuunt motum circularem.] *Comets, as disc-shaped bodies, reject circular motion.*

p. 338, and Book VII, pp. 419 and 434, has been shown; which perpetually turn their flat surface toward the Sun and the Earth, and so advance with an unmoved face, like the Moon (except for a certain cometary libration, of which we shall have to speak later): and hence comets also necessarily follow a rectilinear motion.

But so that everything may be demonstrated to the eye, it will not be out of place to compare a comet, as a disc-shaped body, and its motion, with a ship in agitated water: for in this way no little light will be added both to the matter itself and to the demonstration.

[Margin: Motum Cometarum cum motu navium conferre,maximoperè conducit.] *To compare the motion of comets with the motion of ships is of the greatest help.*

But, you will say, how, I ask, can comets moved in the highest and most tranquil aether be fittingly compared with ships travelling on a deep and windy sea? Are they not things that differ by the whole breadth of heaven, and are enormously at odds with one another? But whatever the case, you will nevertheless perceive, God willing, that comets and ships, in respect of motion, are joined by a singular bond of kinship; so much so that once the motion of the one is rightly understood, the course of the other is not unknown either: as we shall explain at greater length a little later. And so that the matter may come out clearer and more evident, since it calls for very deep contemplation, I shall first set out certain positions, or principles; which, as they are solidly founded in nature, so will also be easily demonstrated hereafter.

[Margin: Nam utriusq̃; motus ſimilibus planè gaudet affectionibus : at[[q́/q̀]]; ita cognito uno, alter non ignoratur.] *For the motion of each enjoys plainly similar properties: and so, once the one is known, the other is not unknown.*

[Margin: Solida principia.] *Solid principles.*

1. Every body, the more it is resisted, the more laboriously and slowly it is moved; conversely, the less anything strives and struggles against a movable body, the more easily and quickly it is carried forward.

[Margin: Reſiſtentia impedit motum.] *Resistance hinders motion.*

2. Any body whatever that is thin, extended, and also pointed, or sharp, if it directs forward, toward the region it is heading for, the lesser thickness of the body, or its point, or a sharpened side, passes much more readily and swiftly both through water and through air and aether, or any other liquid matter whatever, than another body that is thicker, blunter, and less tapered.

[Margin: Corpora tenuia & faſtigiata facilius medium quoddam trajiciunt.] *Thin and tapered bodies pass more easily through a medium.*

3. Every disc-shaped body that extends both its flat surfaces to the sides, but extends the thickness, or thinness, of the body forward, toward where it is moved and driven: such a body, I say, the more it inclines as it runs, or turns or opposes one or other of its flat surfaces to its set path, the more its motion is hindered and retarded; moreover, that body deviates and strays

the more from the path once taken, the less it keeps that thin, or sharpened, side, or point, turned toward its path as at the beginning; or the more it turns the flat surface of one or the other side, and turns it toward its path. By contrast, a disc-shaped body that at first advances exposing its flat surface to its course, but afterwards bends and extends its sharper part more and more toward its path: the motion of that body is accelerated the more, the less it faces forward with its flat surface: provided always that the same and equal impetus and impressed motion is assumed.

[Margin: Motus corporis diſciformis, quomodo retardetur atq́; obtorqueatur : rursus etiam acceleretur.] *The motion of a disc-shaped body: how it is retarded and twisted aside; and again how it is also accelerated.*

4. But to take in everything in three words: bodies are moved in the direction in which they can be moved more easily and are less hindered.

[Margin: Summa rei.] *The sum of the matter.*

That these things are so and not otherwise I shall make clear by the following diagram: in which parallel lines, set at an equal distance from one another and drawn, a certain

[Margin: Schemate poſitiones præcedentes elucidantur.] *The preceding positions are elucidated by a diagram.*

quantity, or a certain space, of water, or of air, or of aether, enclose: for example, let any intervening space enclose certain feet, ells, perches, or any other measure whatever, or one determined in miles or in any other way whatever, whether of water or of air or of aether, provided only that the said spaces contain the same quantity. Next, let a motion be supposed upward, excited either by a rather strong wind or by any other cause whatever, internal as well as external. At the outset, I say, any flat-shaped body whatever (whether it is of circular figure, or oblong, or of any other different, irregular [figure], it makes no difference) that is carried forward with its thinner or sharper side, following the course of the impetus or of the impressed motion, whether in water or in air (like a ship travelling with a favourable and following wind, and also along the current of the water): that disc-shaped body advances more readily and more swiftly, and its power is greater, as the mechanicians say, than when it inclines against that course of the motion, the course of the wind, or the flow of the water; where the power of that body is less. Moreover, the greater that inclination and turning-toward is, and the more it approaches a right angle, the more laboriously and slowly the body is moved; and indeed most slowly of all at the normal angle itself; that is, where the body, along its length, or flat, cuts the advance of the motion, or the line that it describes in its course, passing across it and crosswise: so that, given this inclination and turning-toward of any body, a different power results.

[Margin: Corporum diſciformium tenuiore latere rectà antrorsùm moventium potentia major eſt; contrà inclinatorum minor.] *The power of disc-shaped bodies moving straight forward with the thinner side is greater; by contrast, that of inclined ones is less.*

For the cause is this: the more obliquely such a disc-shaped body, carried across, is inclined with respect to the path of its journey, the greater the resistance and the greater the weight it meets, so that it is the less able to persist continually in the motion once acquired; rather, as the inclination grows more and more, its motion must gradually be extinguished entirely at last, and it comes to rest. This I shall demonstrate to the eye by this slight sketch, however briefly, yet clearly. For at number one of the annexed figure you see a certain flat-shaped body *a b*, moved along the length and the flat of its own extended body, and also in the direction of the impetus of the motion; against it only a single space of water or air, enclosed by two lines, strives: and since this resists only very little, in relation to that body and the impressed motion, this disc-shaped body passes through that medium with no difficulty and very swiftly. At number two, however, where the same body advances more obliquely with respect to the direction of its course, it now meets a greater resistance from a heavier weight set against it: therefore it advances not as swiftly, nor lightly, but more slowly and sluggishly. For in the former position only a single space of water, or of aether, struggles against that body; but in this second inclination three or four spaces are now set against it, to be passed through. At number three, where the inclination of the body is still greater, six spaces now resist; at number four, seven; at no. five, nine; finally, at no. six, eleven spaces now struggle against the same body as it advances at an entirely normal angle with respect to the run of the lines and of the motion, that is, transversely or crosswise.

[Margin: Corpus extenſum, quò magis alterutrâ fa[[c/e]]ie planâ curſum versùs inclinatur ad angulum rectum, eò ægriùs, tardiusq́; movetur.] *The more an extended body is inclined with one or other flat face [?] toward its course, at a right angle, the more laboriously and slowly it is moved.*

Therefore any body that meets with greater resistance, and has a greater weight set against it, is itself moved with more difficulty, and consequently also more slowly. This

[Margin: Principium per ſe notiſſimum.] *A principle most evident in itself.*

Diagram. A full-page engraved plate, with no text on the page. The whole field is covered with fine, gently waved parallel lines running from top to bottom, in three vertical panels. Left panel, upper part: six narrow hatched bars, one below the other, the first upright along the lines, the next four leaning progressively further from the upright, the sixth lying straight across the lines. Left panel, lower part: three pairs of dark solid shapes: an inverted and an upright triangle, a narrow and a broad rectangle, and two narrow upright shapes, one pointed at the top and one pointed at the foot. Centre panel, upper part: solid lines crossing at a single point, a vertical, a horizontal and five oblique lines, with dotted lines fanning out from the same point to the upper right. Centre panel, middle part: three hatched bars, each upright above and bent off at its foot, without letters. Centre panel, lower part: an upright hatched bar and, beside it, an upward-pointing arrow with a lozenge head and a feathered foot, the arrow without letters. Right panel: nine hatched bars, one below the

other, turning by steps from nearly across the lines to nearly along them. The labels engraved on the plate:

- Left panel, upper part: 1 (larger numeral, outside the lines at the left; drawn like a J). Six bars, each with a at one end and b at the other, numbered 1 to 6 beside them (the small 1 drawn like a J); a at the top of the upright first bar; a at the upper right and b at the lower left of bars 2 to 5; b at the left and a at the right of bar 6.
- Left panel, lower part: 2 (larger numeral, outside the lines at the left). M (left of the inverted triangle), L (right of the upright triangle), N (left of the narrow rectangle), O (right of the broad rectangle), P (left of the shape pointed at the top), Q (a script capital, at the upper right of the shape pointed at the foot).
- Centre panel, upper part: 3 (larger numeral, at the top). a (the point where the lines cross); b (top) and c (foot) of the vertical line; k (left) and l (right) of the horizontal line; e, f, g, one letter not settled between h and b (transcription line F37), and i at the upper-left ends of the oblique lines; m, n, o, p, q at their lower-right ends. Dotted lines from a end at d (straight up), r, s, t, u, w, and x (continuing the horizontal line beyond l).
- Centre panel, lower part: 4 (larger numeral). A (left of the upright bar), b (its top), c (its foot).
- Right panel: I, H, G, F, E, D, C, B, A (left of the nine bars, from the top down); the bar at B with b at its top, a at its right and c at its foot; the bar at A with b at its top and c at its foot. 5 (larger numeral, to the right of the panel, level with E).
- *Fig. T.* (foot of the left panel): Fig. T.
- *Aut. ſculps.* (foot of the centre panel, in script): Engraved by the author.

since [it] is clearer than light, and is evident from nature itself, so that it needs no further demonstration, therefore what I was just asserting is also most true, beyond any contradiction: that a flat-shaped, extended body is set in motion more easily and more swiftly if it is carried forward with its thinner side, that is, along the direction and the impetus of the motion, than when it sets its flat, spread-out and longer face against its course; and that the more sluggishly and with the more difficulty, the greater the inclination of that body is. Hence ships too are carried forward more readily and more swiftly, for the same reasons given above, if the prow points toward the opposing quarter than if it inclines to the sides. Likewise a fan: the larger it is, and the more it approaches a direction parallel to the horizon, the more laboriously it is indeed moved; but on the other hand it stirs the air more sharply and raises a stronger wind. By contrast, if the fan is moved with its flat surfaces upright, that is, with the thinner part of its body, along the course of the motion, then it passes through the air more easily, but without any notable stirring of the air and perceptible wind. The reason is the same: namely, the greater and the lesser resistance of the air; from which the power of that body turns out greater and less.

[Margin: Conſequentia infallibilis.] *An infallible consequence.*

But if anyone should wish to infer that the air neither hinders nor helps falling things in any way, and that falling things, whether they are large or small, whether of wood or of bronze, fall equally swiftly — as Cabeus, among others, firmly lays down in Book I of the *Meteorologica*, Question VI, p. 98; for he says: *The fact that all heavy bodies of any size whatever, and indeed of any shape, are moved through the same space in exactly the same moment of time persuades us that the air does nothing in that motion, neither for nor against the speed; for if the air did anything, an inequality of time in the fall would necessarily be introduced* — I reply, however, that there is a great difference between the fall of falling things and a lateral motion that comes, or is impressed, crosswise from a certain side; and further, that there is much difference between that which falls with its face always unchanged and that which, as it moves, continually inclines and turns itself. Two globes of different size do indeed fall through the same space in an equal interval of time; but this comes only from the unequal weight; and this inequality of weight in turn compensates the inequality of quantity: moreover, the smaller globe, as it is lighter than the other, so is it also smaller. And hence it does not meet so great a resistance of the air as the larger one does. Add to this that every falling thing must have a certain gravity of its own, so that while it falls it can overcome the medium entirely, and fall perpendicularly, and not be the plaything of the air. Since, therefore, everything that passes through the air, or the aether, and at the same time, as it advances, perpetually changes its face and position, or inclines more and more with respect to the orbit, or the trajectory line, along which it advances — being, that is, an oblong, flat-shaped, or disc-shaped body — I say that this very thing by no means always keeps an even impetus and course, but is gradually slowed by the medium it flies through, and at last even brought entirely to a stop.

[Margin: Aër non obſtat cadentibus : ſiquidem inæqualia pondera æq́; velociter decidunt.] *The air does not hinder falling things: since unequal weights fall equally swiftly.*

[Margin: Quidnam ſit differentiæ inter lapſum rerum cadẽtium, & motum lateralem impreſſum.] *What difference there is between the fall of falling things and an impressed lateral motion.*

[Margin: Cur motus inæqualium globorum cadentium æq́; velox ſit ?] *Why is the motion of unequal falling globes equally swift?*

[Margin: Omne corpus diſceum inclinatum à medio, quod trajicit, impeditur & retardatur.] *Every inclined disc-shaped body is hindered and slowed by the medium it passes through.*

Besides, they also differ in this, that the natural motion of descending heavy bodies, which proceeds of its own accord, feels no resistance from the air, and therefore continually increases and becomes swifter; but the violent motion of projectiles and javelins, which arises from an impetus, a blow or a throw, and by an impulse is produ-

[Margin: Differentia gravium deſcendentium,& trajectorum, ex motu violento.] *The difference between descending heavy bodies and projectiles, from violent motion.*

ced, certainly acquires a resistance: and hence it is gradually diminished and becomes slower. And let this suffice for the demonstrations of the first and third Positions.

As for the second position, namely that a body that is thinner, and more pointed and sharpened, whose power is greater, is moved more easily and more swiftly than blunter and thicker ones: this can indeed be demonstrated with equal ease from almost the same ground. For the body O in the second sketch of the preceding Figure, advancing with a broader front stretched out toward its course, meets a greater resistance of the air, or of the medium to be passed through, than the body N, set in motion with a narrower front exposed toward its direction. For seven spaces of that medium struggle against the former, but only two or three against the latter. And a body against which a greater force and a stronger resistance is set is moved with more difficulty and more slowly, as is abundantly clear even to beginners, so that it would be entirely superfluous to explain it with a great many [words].

[Margin: Demonſtratur corpus tenuius & cuſpidatum faciliùs velociusq; moveri.] *It is demonstrated that a thinner and pointed body is moved more easily and more swiftly.*

But why does a tapered body, such as a triangle or a pyramid, if it is carried with a favourable motion, namely with its point forward, advance more readily through water as well as air than a square body, a cube, or anything else of that kind? Further, why can two homogeneous and pointed bodies, as L and M in the same sketch, be of entirely different power, and so not be moved with equal ease, nor with equal speed, unless they are disposed in exactly the same manner and the same position, and present a similar face to the flow of the motion? And above all, when the vertex of the body goes first, why does it advance much more easily and more swiftly than when the base is carried in front? These very things, I say, must be sought from entirely different reasons, drawn from Optics and Statics.

[Margin: Poſſunt homogenea corpora ejusdem omninò figuræ & magnitudinis, eſſe diverſæ potentiæ.] *Homogeneous bodies of exactly the same figure and size can be of different power.*

The mechanicians have indeed demonstrated a certain proposition: that in homogeneous bodies (that is, bodies displaying the same figure, species and magnitude) the proportion of the powers and of the velocity is the same as that of the magnitudes. But this proposition concerns only weights, namely the balance and the lever; in motion, however, even homogeneous bodies enjoy entirely unequal powers, as you will presently see more clearly. For although, when two equal acute-angled triangles present to their course the one its vertex, the other its base, an equal number of lines, or an equal space of air and of water, or a weight, resists and struggles against them, as is evident from the

diagram above, I say nevertheless that the triangle that directs its vertex along the course of the motion, forward [in conſequentia], proceeds much more easily and more swiftly than the one whose base goes first toward the direction of the motion. For these bodies possess similar properties and effects, as wedges [do]. Wedges, moreover, as we have learned from Statics, are of such a nature that the more acute they are, that is, the more acute the angle at the vertex, the stronger and fitter they are for cleaving, splitting and moving; and that with less force, or power, and also with a lighter motion. There is likewise no need to demonstrate this, since mechanicians such as Guidus Ubaldus, Daniel Môglingius [Daniel Mögling], Pappus Alexandrinus [Pappus of Alexandria] in Book VIII, Prop. IX, Marinus Merſennus [Marin Mersenne] in *Mechanic.*, Prop. 12, and others, have already done it fully, chiefly from two reasons, to set the matter out briefly. First: that a wedge is nothing other than two opposed levers, which operate joined rather than disjoined. Second: that

[Margin: Corporum pyramidatorum motus eſt velocior, quæ cuſpide,quàm eorum quæ baſi antrorsùm versùs feruntur.] *The motion of pyramidal bodies that are carried point forward is swifter than that of those carried base forward.*

[Margin: Quò acutiores ſunt Cunei, eò major eſt eorum potentia.] *The more acute wedges are, the greater is their power.*

[Margin: Quænam hujus rei ſint rationes.] *What the reasons for this are.*

a body on a slightly inclined plane, that is, one less elevated above the horizon, can be moved more easily than on a plane at a greater angle of inclination and rising more above the horizon.

Since, therefore, an angular or pyramidal movable body, turned with its point forward [in præcedentia] (as L in the preceding figure, at no. 2), presents the form of a wedge, this body, I say, in passing through and moving the air or the water, is of the same nature as a wedge, and also produces equal operations and powers. Hence, since a more acute wedge cleaves and splits any body whatever with less force, or impetus, than a blunter one, an angular and pyramidal body too certainly penetrates the medium in motion, whether air or water, more readily, and so also moves more swiftly than another of its kind that is blunter. Consequently such a pyramidal or pointed body too, by sending its vertex ahead, can be moved much more easily and more swiftly than a body that exposes its base toward the impetus, as can be seen at M. Not only because the base is blunter and broader than the point, or vertex, as no one fails to understand; but because that body is nothing but an inverted wedge, by no means exerting, from a natural principle, such forces and powers as a direct wedge.

[Margin: Corpus cuſpidatum ſequitur naturam cunei, quà motum.] *A pointed body follows the nature of a wedge, as regards motion.*

Second: why, however, such a pointed body, if it is moved toward the opposing quarter, penetrates and cleaves any medium whatever more lightly and more swiftly than any blunter one: this I shall now deduce still more readily

from other reasons drawn from Optics. The opticians, for their part, suppose the following positions as undoubted principles.

[Margin: Corpus pyramidatum medium quodcunq; leviùs velociusq; ſcindere;rationibus Opticis deducitur.] *That a pyramidal body cleaves any medium whatever more lightly and more swiftly is deduced from optical reasons.*

1. The direct action of rays is far stronger than the oblique.
2. A perpendicular ray is the strongest of all in direct action; the rest, according as they recede more or less from the perpendicular, are correspondingly more or less powerful in their direct action. To put it more plainly: the more perpendicular rays are, the stronger they are, and the more they resist; but the more obliquely they fall, or strike against some body, the weaker they are, and the less they struggle against it. And so perpendicular rays are the strongest of all, because they are reflected back into themselves.

[Margin: Principia Optica.] *Optical principles.*

[Margin: Radii perpendiculares ſunt omnium fortisſimi.] *Perpendicular rays are the strongest of all.*

Since, therefore, a pyramidal or angular body advancing vertex-first along the flow of the motion (as the body L in the diagram above) strikes against only a single perpendicular, or unrefracted ray, while all the other lines, as they fall at an oblique angle, are likewise far weaker than those lines and rays that run against an inverted pyramid, that is, against its base, all and each of which are perpendicular, and so far stronger for resisting: therefore we prove again and again that any body whatever set in motion, facing forward with its point, or its thinner side, passes through any medium much more easily and more swiftly than another advancing with its blunter side against the way [adverſâ viâ]. From this it is further established that in a more acute body launched in the opposing direction [in adverſum exploſum] the incident rays are far more oblique, and so also weaker, than in a blunter one, against which more direct rays strike, that is, rays approaching nearer to the perpendicular. Hence a greater force and strength struggles against this body than against that more acute one. So much so that a blunter and thicker body, with a stronger power, more slug-

[Margin: Lineæ perpendiculares validiores ſunt ad renitendum obliquioribus.] *Perpendicular lines are stronger for resisting than more oblique ones.*

gishly; but a thin body, tapered to a point, is moved more promptly and more swiftly with a lighter power: which was to be demonstrated.

For these reasons ships are for the most part built oblong and tapering gradually to a point, so that they may not fail to be set in motion the more readily and more swiftly, and to make sail. And hence ships, the more they narrow down to a sharper point, the swifter they are under sail [velivolæ], or the fitter for sailing.

[Margin: Cur navigia conſtruantur oblonga ?] *Why are ships built oblong?*

Having therefore demonstrated how a body can be set in motion more lightly or with more difficulty, it follows that we should make good what we promised: namely, how a flat-shaped body is moved with its sides upright and spread out, and directed toward the sides; whether of itself, by some inherent force, with all accidental and violent disturbance, or resistance, removed, while it receives its first impetus forward [in adverſum], it can go otherwise than continually straight ahead; or whether it can to some extent bend the course once begun, or turn aside from it? First: it is indeed altogether necessary that such a disc-shaped body, on which an impetus for a straight course has been impressed right from the beginning, should proceed perpetually straight on, without any deviation, or deflection, at all; that is, so long as the same impetus, the impressed motion, or moving power, lasts, from wherever that force may come: provided that no other [motion], contrary to the former, meets it from elsewhere and destroys that straight motion with some force (whether it now takes its origin from some other impressed motion, or from a certain collision with another body, or from a natural antipathy, or sympathy, or from some occult magnetic force, it is all the same), so as to deflect that body from its straight path and throw it off.

[Margin: An corpus planiforme ſemel arreptum iter rectum continuò proſequatur; an verò ab iſto ſucceſſivè deflectat ?] *Whether a flat-shaped body, once it has taken up a straight course, continually pursues it; or whether it gradually turns aside from it?*

These things certainly, indeed, deserve to be demonstrated thoroughly, since rectilinear motion rests solely on this matter, and very many phenomena cannot fail to be fittingly explained from it. But so that the matter may turn out more happily, and everything be clearer, I think it worthwhile that this trajectory motion be compared with the motion, or sailing course, of ships; and so that it be duly demonstrated beforehand by what reasoning, or in what way, ships can be steered and directed in every direction by means of that admirable rudder [gubernaculi]. When these things are rightly understood, no one will fail at the same time to grasp thoroughly our rectilinear motion of comets, on which it will be necessary to pour out so many words a little later.

[Margin: Demonſtrandum priùs eſt : quo pacto navigia gubernaculo regi ac dirigi queant.] *It must first be demonstrated how ships can be steered and directed by the rudder.*

And this question about the helm [clavo] of ships, or the rudder, cannot fail to be welcome and pleasant to those eager for knowledge. Indeed, although that part of ships may seem to be very well known almost to the bleary-eyed and the barbers, as the common proverb says, yet hardly everyone, I think, will give solid reasons for the steering action of the tiller [directionis temonis]: namely, in what part the principal power of the helm lies hidden? Add to this that this very matter is not in the least foreign to our aim either, but rather serves it in the highest degree; so that it rightly pertains not only to Hydrography but equally to Cometography.

[Margin: Genuinæ rationes directionis temonis, non omnibus patent, ut ut gubernaculum nemini non ſit notiſſimum.] *The genuine reasons for the tiller's steering action are not evident to all, however true it is that there is no one to whom the rudder is not very well known.*

The rudder of ships, moreover, is rightly counted among the most admirable of things, even by those who are ingenious beyond the rest, if you examine its powers more deeply; and above all if you consider its shape, and its slight proportion with respect to the ship and to the ship's weight; and, on the other hand, what great forces it exerts, both with what ease and speed, and with how slight a force, an immense mass is steered? So much so that not only

[Margin: Navigiorum gubernaculum inter naturæ admiranda meritò habetur.] *The rudder of ships is rightly counted among the wonders of nature.*

men weak in strength, but even younger boys, can steer a ship laden with very heavy merchandise as swiftly as possible, both alone and with the greatest ease; what of the fact that the motion and operation of the tiller seem to conflict utterly with many principles and positions proclaimed in Statics? For they lay down that, to move a very heavy weight, the greatest force, or the power of many men, is required. But if that very heavy body is to be moved with less force and by fewer men, [they hold] that the work is necessarily carried out more slowly, and over a longer interval of time. On the contrary, the rudder of ships can move and direct an enormous mass in the briefest moment of time, very swiftly, without any notable force (as it seems), with the help of a single man. It is therefore altogether useful that this inquiry be weighed more deeply, especially since (as we have just touched on) the motion of sailing is as similar as possible to the motion of comets and to their direction, and the latter cannot fail to be demonstrated best of all by means of the former.

[Margin: Vires temonis, principiis quibusdam Staticis quaſi refragantur.] *The powers of the tiller, as it were, conflict with certain principles of Statics.*

[Margin: Motus Cometarum per motum velificationis omnium optime demonſtratur.] *The motion of comets is demonstrated best of all through the motion of sailing.*

Indeed, I am well aware that among the older philosophers the most wise Aristotle long ago took great pains to uncover and demonstrate the strength of the helm from definite reasons, as is clear from chapter 5 of the *Mechanical Questions* [Cap.V.Quæſt.Mechan.]. For he says: *Why does the rudder, though it is small and at the very end of the vessel, have such great powers that by a little tiller, and by the strength of a single man who otherwise exerts it only moderately, great masses of ships are moved? Or is it because the rudder is a lever, the load the sea, and the helmsman the mover?* etc. Yet in my judgement at least, he does not reveal his meaning clearly enough (which, however, I would say with the leave of so great a man), nor does he explain its movement altogether correctly: from where does that great force and power arise? He does indeed hold to the opinion that the movement derives from the strength of the lever, as indeed cannot be denied; but he does not apply the power of the lever correctly, that

is, the way in which it exerts that power. According to Aristotle's view, the rudder is the lever, the sea the weight, and the helmsman himself the moving power; but the matter stands far otherwise, as you will presently perceive.

[Margin: Ariſtoteles jam operam dedit, ut clavi exponeret vires.] *Aristotle already took pains to set out the powers of the helm.*

[Margin: Quomodo præfatus Philoſophus clavi commotionem & potentiam explicet.] *How the philosopher just mentioned explains the movement and power of the helm.*

Nor do other, more recent philosophers and mechanicians hit the matter exactly [rem acu tangunt]. For Möglingius, to say nothing of the rest (as one can read in his Commentary on the question of Aristotle mentioned above, p. 134 *Mechan.*), asserts that the whole length of the ship from prow to stern is like a lever; so that he lays down outright that the end of the lever at which the moving force must be applied lies in the ship itself, and not at all outside it in the sea. Although elsewhere he contradicts himself, when he in turn ascribes the moving power to the water, yet in the end he comes down to this opinion: that the longer the ship, the more easily it can be steered by means of the rudder. For, he goes on, the longer the lever, the less power is needed to lift or to push something forward. In short, while he strives to uncover and set out the matter more clearly than Aristotle himself, he sooner entangles and clouds it.

[Margin: Quid Recentiores Mechanici hâc de re ſentiant.] *What the more recent mechanicians think on this matter.*

As for my own opinion on this matter, I likewise fully hold that the rudder must indeed be considered as a lever (although it can also be likened to the wheel and axle [axi in peritrochio], of which more later), but that it operates in an entirely different way. First: for us the ship is the weight, which

[Margin: Autoris ſententia de commotione,& virtute gubernaculi.] *The author's opinion on the movement and strength of the rudder.*

is to be moved and directed in every direction. Second: the rudder is a lever insofar as, at the part of the vessel where it is attached, a fulcrum [fulcimentum] is provided, on which that lever rests. For, as we have learned from Statics, a lever always needs, as it were, a rest, a prop, or a seat (that which is called the fulcrum) if some weight is to be lifted, or moved, with slight effort. From this Aristotle rightly concludes, in chapter 3 of the *Mechanical Questions* [Cap.3. Mech. Quæſt.]: *Small forces move great weights with a lever.* The nearer the weight to be moved stands to the fulcrum, the more easily, and with the less power, it is lifted: that is, the shorter that part of the lever which lies between the weight and the fulcrum, the longer is the other part of the lever, lying between the fulcrum and the tip, to which the moving power is applied, fastened, or struck against; and the more lightly and more swiftly the weight is raised and set in motion. This is established from Mechanics, to which I refer the reader who is not altogether ignorant of the principles of Mechanics, so that I may not seem to dwell on these matters too long.

[Margin: De vecte & fulcimento.] *On the lever and the fulcrum.*

Third: the end part of the helm, which is kept in the inner part of the ship itself, otherwise called the rudder [gubernaculum], at which the shipmaster [Nauclerus] sits, and by means of which the whole helm is moved, [is] not in truth the end or tip of the lever at which the moving power is located, that is, the helmsman (to whom very many ascribe the moving power, and whom they regard as an animate power, as the mechanicians put it); but [I hold] that it is that end part of the lever at which the weight to be set in motion rests, between [it and] the fulcrum to which the helm is attached. But the remaining part of the helm, projecting outside the ship, otherwise called the tiller [temo] by the learned, is for me that part of the lever to which the moving power comes, or is applied. The inanimate power itself, which produces all the movement and force, is the wind and the sea; in rivers, however, in which flow and ebb occur, it is the water and the current, or rowing, as in skiffs and triremes. But when these are lacking — namely the wind, the current or the running of the water, the rowing, or some driving of the vessels, and the water — no notable operation of the helm takes place, even if only one or the other of the two is lacking. For two things are necessarily required to steer ships: continuous motion, and the steering action of the tiller [directio temonis]. Therefore, the more violent the wind, and both the more or less water flows to the tiller and the more directly or obliquely the water strikes the tiller, the greater, or the lesser, is the movement of the ships.

[Margin: Gubernaculum quatenus cum vecte conferatur.] *How far the rudder may be compared with a lever.*

[Margin: Quid ſit temo.] *What the tiller is.*

[Margin: Quænam neceſſariò requirantur ad velificationem.] *What things are necessarily required for sailing.*

But what office, you will ask, does the helmsman perform? Does he contribute nothing at all to this business? For no doubt you are wholly and entirely persuaded that he, directing the rudder by hand, is the principal cause of the strength set in motion, or of the force impressed? But I by no means attribute so much to him. Ships, it is true — that is, weights to be set in motion — certainly cannot be moved and steered at all without a helmsman governing the helm, or something else taking his place; but it does not follow at once from this that the helmsman just mentioned is himself the genuine moving power, namely the strength and force that chiefly exerts the movement. For the shipmaster does nothing except merely bring the helm to a certain inclination and hold it there, so that it is not shifted from its place; and he accomplishes nothing more than one who simply applies a lever to a weight and sets it underneath, and who takes care that the lever does not fall, is not thrown down, or shifted, but adheres firmly and continuously to the weight to be moved; but by no means so that, at the end part of the lever, he should apply any, or

[Margin: In commotione navium, quid præſtet Gubernator ?] *In the movement of ships, what does the helmsman accomplish?*

[Margin: Gubernatorem non esſe potentiam moventem.] *That the helmsman is not the moving power.*

bring to bear power, when an adequate weight, or a sufficient moving force, is already present to it: such as the water striking or washing against the tiller, to which the wind imparts power. For ships are also steered without any helmsman at all, provided that the rudder is properly fastened and fixed, so that it does not nod or waver. And this fastening and securing of the rudder brings it about that ships go forward [in conſequentia] along their length, turn aside, and are steered in every direction — according, that is, to the position, direction and inclination of the tiller. So the helmsman can do nothing whatever more (as we were just saying) than merely bring the rudder — that is, the lever — correctly to the weight, and hold it firm. The helm in question is fixed either by a small rope, or by the hands, or by the feet; whether the helmsman stands or sits makes no difference. For unless the rudder were made firm in any given direction by this or some other means, ships would by no means be steered correctly and properly: just as a lever [is not] able either to move or to lift anything, however great the power that assists it, unless it adheres continuously and tightly to the weight to be moved.

[Margin: Sed aquam ad temonem alluentem.] *But the water washing against the tiller.*

But to make the matter still clearer, I shall explain and demonstrate everything by a diagram. In the figure T above, then, at number 3, let the parallel lines drawn be the water, whose course, whether from the current or from the winds, runs upward; let d b a be the whole length of some ship; d the prow; a the stern, to which the helm is fixed; and this in such a way that a c is the tiller, namely the end part of the helm hanging down from the stern into the water; and a b the rudder, namely that part of the helm which is inside the ship, at which the helmsman stands or sits, and by means of which the whole helm is governed. When the helm b a c has thus been set along the length of the ship d b a, so that the tiller points out from the stern entirely and wholly in a straight line, and is held, or secured, firmly and steadily in that same position; and when, moreover, a following and favourable wind is blowing, which fills the sails from the stern, or some other impressed motion arrives in line along that course: then, I say, the vessel necessarily goes forward only straight ahead. For the force, or power, of the sea or of the water, which flows back from the swifter advance and motion of the ship, strikes the tiller sharply on neither side, much less shifts it; rather, it flows gently past, parallel to the line of the tiller a c, as the lines drawn in the diagram clearly show. In the same way, too, the ship would go perpetually straight ahead, according to the course of the wind, if the rudder a b were free from every reflected — or oblique, violent and external — motion, and were wholly subject to spontaneous motion only. Then, I say, that very rudder would at once of its own accord throw itself into the length of the vessel (namely with the sails set crosswise with respect to the length of the ship, and with the wind blowing straight from the stern), where

the force of the water can strike neither side vehemently, much less rush upon it with violence. It behaves like the vanes of ships [appluſtrium navium] and the wind-indicators standing on the tops of towers and houses, provided that they can turn about an axis with any very gentle motion, whatever quarter they may face: those vanes, I say, as soon as the wind begins to blow — unless they are tied or fixed, and provided they are entirely free from every violent rest — at once, following the course of the blast, of their own nature direct their points toward the wholly opposite quarter (and the tillers closely imitate these points of the vanes); so that the wind flies past both sides of the vanes and wind-indicators with a parallel motion, or

[Margin: Dilucidè omnia demonſtrantur, beneficio ſuperioris Iconiſmi pag. 572 inſerti.] *Everything is clearly demonstrated by means of the figure above, inserted at p. 572.*

[Margin: Quâ ratione in directum navigia ferantur.] *How ships are carried straight ahead.*

[Margin: Appluſtria temones æmulantur, & viceverſa.] *Vanes imitate tillers, and vice versa.*

touches [them] equally and quite gently. In this position the power of the wind is always the least of all, or the very weakest; just as, in a similar straight direction of the tiller, the force of the water is also always the very feeblest. And for this reason, too, vanes and wind-indicators always direct themselves toward the flow of the blast — that is, toward the quarter opposite to it — and stretch themselves out.

But when the helm is inclined, or bent, to this side or that, and fixed there, the ship no longer goes forward straight ahead, but of necessity proceeds obliquely, at a definite angle of inclination, according to the more oblique inclination and direction of the helm. For example, let the rudder a b — that is, the part inside the ship — be set a little toward e, to the left, so that e a represents the rudder, and a q the tiller, which is now placed toward the right, while the rudder a e is to the left. Then, certainly, the ship a b d is no longer driven straight (even with a favourable wind) toward the quarter wholly opposite to the blast; but, with the helm bent in this way, it must turn aside somewhat to the right from its former straight path a b d — that is, in quite the contrary direction from the rudder e — to the extent that the prow then curves toward r. Assuming, then, the wind, and a moderate and properly proportioned motion of the ship (otherwise, believe me, the matter would turn out far differently, so that the inclination of the helm could be not a little less than the inclination of the ship, according as the wind and the flow of the water are more vehement and more rapid, or weaker and slacker — which should be carefully noted), the inclination of ships occurs at the same angle at which the rudder e deviates from b, or the tiller from the former straight line d b a c: that is, however great the angle b a c, or c a q, is (as being vertical angles), so great also is the angle of inclination of the ship d a r.

The reason for this inclination is as follows. Since the whole helm no longer points directly to the flow of the wind, or of the blast, but now somewhat obliquely, as is seen at e a q, the force of the water therefore does not flow gently against the tiller as before, but now strikes it with two lines; whereas in the former straight position of the rudder no line at all dashes against the tiller. The violence of the water therefore drives the tiller a q as it were toward c, so that the rudder a e is at the same time pushed toward b (since it forms a straight line with the tiller, and is as it were tied to the ship at e; or, what comes to the same thing, is as it were bound fast by the feet or the hands of the shipmaster sitting at that place e). Hence the prow d is necessarily moved away toward r; and so the movement of the ship (which you should note well) and the inclination of the tiller never fail to approach each other. Therefore, the greater the inclination given to the ship — or the more obliquely the ship proceeds — the nearer the ship, or the line a r, comes to the tiller a q.

[Margin: Quâ ratione ſub certo inclinationis angulo navigia procedant.] *How ships proceed at a definite angle of inclination.*

[Margin: Quò plùs aquæ temonem ferit, eò vehementior, & obliquior eſt commotio navium.] *The more water strikes the tiller, the more vehement and the more oblique is the movement of ships.*

From this it is clearly gathered that the moving power — quite contrary to the opinion of Aristotle — falls on the tiller a c, and by no means on the rudder a e. For it is the nature of a lever that, when it is pressed down at the end designed for that purpose, the weight at the opposite end of the lever is raised in turn; to the extent that this end, to which the weight adheres, as it were comes nearer to the other end of the lever, to which the moving power is applied; that is (so that you understand it correctly), it approaches the very place where the said end of the lever originally stood, as is evident from the drawing. For while the tiller a q is driven toward c by the power of the water, the ship a b d itself bends its course toward r; and hence r and q not

[Margin: Potentia movens non ad gubernaculum; ſed ad temonem accidit.] *The moving power falls not on the rudder, but on the tiller.*

are so far apart from each other as d and c in the former direction. In the same way, too, the motion of the vessel is now carried toward the course to which the violence of the sea, or the flow of the water, draws the tiller; but [to put it] more clearly: while the lever e a q is pressed down at q toward c, d raises itself toward r of nature's own accord, as a lever does. But the contrary would happen with the movement of ships if the helmsman at d were the moving force, and the sea the weight to be moved at q; in that case, I say, with the helm in the direction shown at e a q, the ship would by no means be driven toward r, but of necessity toward y. Now, however, we have learned by experience that when the rudder is moved from b to e, the ship moves not [toward] y (that is, toward the side on which the rudder e is placed), but, drawing back, entirely toward the contrary side, toward r — that is, away from e, or b. Therefore the position stands unshaken: the ship is the weight to be moved; the shipmaster is

nothing but one who holds the lever, or rudder, and attaches it to the ship as if by binding it; and the tiller q, p, o, etc. is that end of the lever on which the moving power strikes — a force, or strength, that is imparted by means of the stream, or the flow of the water.

[Margin: Summa ſententiæ Autoris, de directione navium.] *The sum of the author's position on the direction of ships.*

For the rest, in quite the same way, if the ship must be directed at a greater, or more oblique, angle of inclination — that is, toward the same quarter — then, with the rudder set at f, the tiller withdraws to p; at an equal angle, of course. For c a p and f a b are vertical [angles]. In such a direction of the helm, therefore, more water — namely, water comprised in three lines — now washes against the tiller a p than washed before against the tiller a q. Add to this that, at this inclination, the water strikes the tiller a p more directly than a q; hence a p is also moved more vehemently than a q; and consequently the whole ship, too, inclines more toward s, since p is driven toward c, where it is held by the power of the water and, as it were, fixed. Further: the farther the rudder is from b, or the more oblique the line of direction — as at g, h, i, or k — the more the ship bends to the right, toward t, u, w and x. The reason is the same: since more water flows to the tiller and glides onto it — that is, a greater force arrives. For not only do successively more lines (as is evident in the diagram: on a n, 6 lines fall; on a m, 7 lines; and on a l, more), but they also roll down onto the tiller gradually more directly; so that the ship must consequently deviate more and more, since the angle l a c is greater [than] m a c, and again m a c is still a little greater [than] o a c, and so on in sequence. And so, with the tiller set entirely at a right angle — that is, crosswise with respect to the parallels, as at a l — in such a direction of the helm, I say, the greatest and most powerful force of all strikes the tiller: because all the rays of the water (if one may speak so) are then entirely straight; and besides, the water then falls on the tiller in greater abundance in this direction than in all the other directions. But when the ship is directed to the left, the directions run out the contrary way, as everyone understands.

[Margin: R[[e/é]]s adhuc clariùs dilucidatur.] *The matter is made still clearer.*

[Margin: Quâ directione temo maximam potentiam exerere poſſit.] *In what direction the tiller can exert the greatest power.*

In this way, therefore, by so small a piece of wood, or rudder, an immense mass — a ship, for instance — can be moved and steered in the briefest moment of time by the help of a single man, however weak (which almost surpasses our comprehension); so that it should no longer seem absurd to anyone that a great weight is moved by a slight strength. On this occasion it is rightly asked how ever so very sh-

[Margin: Magnum pondus ab exiguâ virtute moveri poſſe.] *That a great weight can be moved by a slight strength.*

ort a piece of wood, and of such slight breadth, as the tiller can move so huge a mass in the larger ships? For it is implanted in a lever by nature that the

longer its part between the end to which the moving power is applied and the fulcrum, and the shorter, in turn, the other, opposite part lying between the fulcrum and the weight to be moved, the more readily and swiftly any weight whatever is moved and raised. Now the tiller, as the part of the lever at which the moving strength stands, is usually far shorter both than the rudder and than the whole length of the ship (since it makes no difference whether you take the rudder or the ship as the other part of the lever); and yet it nonetheless performs its office, raising so very vast a weight and steering the ship so promptly and swiftly in every direction? It certainly cannot be denied that the longer — or rather the larger — the tiller, the swifter the movement of the vessel; but at the same time it is also entirely certain that whatever the lever loses in length can be made good in turn by a greater and more vehement moving power, as actually happens in this matter through the stronger strength of the sea, or of the stream. Meanwhile, although in larger ships the tiller usually seems to be of slight breadth — that is, of slight length in respect of the lever — it is nevertheless in fact extended far enough, since by its height, or depth (for the tiller reaches from the upper surface of the water right down to the keel itself), it makes up for every deficiency. Accordingly the tiller is very tall (since the depth of a ship runs to 15, 20 and more feet): if it were considered only at the surface of the water, as an extended lever, and the height of the tiller were added to its breadth (for it is the same whether the length of the tiller extends along the surface or into the depth, provided an equal quantity of water washes against it), then, believe me, its length would run to 60, 70, indeed 100 feet — given, that is, a tiller height of 20 and a breadth of 5 feet. Therefore this part of the tiller, or of the lever, at which the moving strength arrives, just as it is much longer than the rudder, or rather than the very length of the ship, so too it is far more powerful and stronger than the other part of the lever, to which the weight adheres.

[Margin: Quâ ratione temo (quatenus vectis adeò br[[e/c]]vis) maxima navigia tam promptè dirigere queat.] *How the tiller (inasmuch as it is so short a lever) can steer the largest ships so promptly.*

[Margin: Etiamſi temones videantur perbreves, opinione tamen multò ſunt longiores.] *Although tillers seem very short, they are nevertheless much longer than is supposed.*

For this reason, in shallow waters and rivers, or ones that are not so deep, where people use low-built vessels, very long helms or tillers are built, as is customarily done in skiffs, boats and punts. Add that a great force of the water and of the stream strikes the tiller; therefore, even if the tiller were somewhat shorter (since floating bodies are very ready to move), the ship would nevertheless still be moved with a lighter effort.

[Margin: Quare navigia in aquis vadoſis longioribus temonibus opus habeant.] *Why vessels in shallow waters need longer tillers.*

Let it suffice to have said this much on how the helm of a vessel, after the manner of a lever and of an assisting power, can steer and move the ship. Now,

before we leave this subject, I shall also add in a few words how the helm of a vessel, and its operation, can be explained by the power of the wheel and axle [axis in peritrochio]? But whoever is anxious to understand all this thoroughly must not be entirely ignorant of mechanics; otherwise everything would certainly have to be treated more fully, and that runs entirely counter to our purpose.

[Margin: Operatio clavi per potentiam axis in peritrochio declaratur.] *The operation of the helm explained by the power of the wheel and axle.*

In the same figure above, at number 3, let a be the axle, where, in the earlier comparison, the helm was tied and the fulcrum of the lever was given; let c, q, p, o, n, m, l, the particular directions of the helm, be the wheel, or rather the spokes [ſcytalæ] on the drum of the wheel; when some moving power comes to them, or is dashed against them; for ex- ample at a l, it must incline toward the side to which the force drives it, that is, toward c in the said diagram; and so the ship a d cannot incline otherwise than toward x, and indeed in this direction farthest of all: since l, of all the spokes, stands farthest from c; and as the remaining ones are nearer to c itself, so the ship, too, then turns less. Moreover, the revolution and turning at l is far easier and also swifter in that direction of the tiller. For although the same, entirely equal, inanimate power is applied at l, it nevertheless achieves more: it moves, or raises, the whole wheel, and consequently moves the ship itself — fixed, as it were, to the opposite spoke — much more easily and quickly than if the moving power fell at m; again, at m more is achieved than at n, and so on. For all things are moved the more readily and quickly, the farther they are extended from the centre, as Aristotle testifies (*Mechanical Questions*, chapter 12). Likewise, chapter 8: *Larger circles are moved more swiftly by an equal power, and move loads;* likewise chapter 9: *things that are lifted and drawn by larger circles happen to be moved more easily and quickly, as with larger pulleys rather than smaller ones, and with spokes likewise, etc.*

[Margin: Quænam ſcytala in tympano maximam producat virtutem.] *Which spoke on the drum produces the greatest strength.*

[Margin: Majoribus circulis faciliùs citiusq́; quid attollitur & movetur.] *By larger circles a thing is raised and moved more easily and quickly.*

Since, therefore, the spoke l is farther from a than all the rest, m, n, o, etc., and so also describes a larger circle, the mass is certainly also moved more, and at once, in such a direction. But that l is removed from the axle a by a greater interval than all the other spokes, everyone will grant without difficulty from the flow of the water, or from the parallel lines, so that there is no need at all here for a fuller demonstration. For a l takes in more parallels than a n, and this in turn more than a o: therefore l stands farther from the axle a than all those that follow; and so l, m move more than o, p, even though an equal force and strength be applied to them. Though, besides this, the power at l is also far stronger, as we said above, than at the other spokes, since it receives more water.

But at c on the wheel (I should like you to note this), even though the power is the most vehement of all, nothing whatever is likewise contributed to steering and turning the ship: because the spoke c and the axle a coincide in one and the same straight line, where they form no angle at all and do not stand apart from each other by the smallest interval. Therefore, even if some weight, and an equal one, were added to it at c, just as to the other [spokes] l, m, n, etc., it would nevertheless still be moved toward the same course, along that straight line a c, with a parallel motion; and hence the power at c can neither incline nor turn the ship, or the weight to be moved, but can only drive it straight on, or carry it forward. Indeed, if we look into the matter more carefully, in that direction of the spoke a c there is in reality no moving power at all: for the tiller, or spoke, a c falls in the same straight line as the ship a d, where the force vanishes entirely; that is, the power or current of the water can strike a c at no angle whatever, but can only flow past it gently, and that with a parallel flow, as was shown a little earlier; besides, it is screened, as it were, by the very body of the ship, so that it cannot be moved or struck by the violence of the sea. Therefore we conclude, again and again and rightly, that in the direction a c the ship by no means inclines, but continually goes straight forward, according to the flow of the wind and of the stream.

[Margin: Quando temo cum navi in eandem incidit rectam, potentia ejus nulla eſt; quò verò angulus, quem temo cum navi conſtituit,ad rectum magis vergit,eò potentia major eſt.] *When the tiller falls in the same straight line as the ship, its power is nil; but the more the angle that the tiller makes with the ship approaches a right angle, the greater its power.*

Lastly, by means of this wheel and axle we likewise prove that the longer the helm, the easier and swifter the steering of vessels. For the spokes, which represent the radii of a circle, as it were, are then longer, and loads are moved more easily and quickly by larger circles, according to the axiom cited above. Next, it can be shown in this way that what Aristotle and Möglingius [?] report is groundless — that the longer the ship, the more readily it is turned and moved — and that the contrary is truer: the shorter the ship, the more easily it is steered in every direction. For just as a longer spoke, inasmuch as it extends farther from the axle, raises greater loads with less effort and moves them more easily — given, that is, a moving power — so, conversely, when a resisting power is supposed, it struggles back more than a shorter spoke. To show this from the same figure: let the length of the ship a d be the spoke on the wheel, or drum; this, I say, when bent from d toward x, is subjected to a greater power of the sea than when, the length of the ship being taken as a b, it is turned toward l; since [at] a x nearly 20 lines resist, but [at] a l only 7. Since, therefore, a longer ship is exposed to greater resistance, it is certainly moved with more difficulty and more slowly than a shorter vessel, according to axiom 1 cited on page 571: *A greater resistance produces a more difficult and slower motion.* This could, lastly, be demonstrated no less by the power of the lever; but since account must be taken of time, I willingly leave it aside on this occasion. Let us betake ourselves

from the waters into the air, examining now at last in what way the directions of any body come about there? — so that in this way we may finally arrive at the comets advancing in the highest aether. This, indeed, would not succeed as we wish unless the way had first been very well paved, namely by elucidating and demonstrating the matters just now brought forward.

[Margin: Quò longior clavus eò levior eſt directio.] *The longer the helm, the easier the steering.*

[Margin: Brevior navis procliviùs dirigitur, contra opinionem Ariſtotelis.] *A shorter ship is steered more readily, against the opinion of Aristotle.*

[Margin: Quò major reſiſtentia,eò difficilior tardiorquè eſt motus.] *The greater the resistance, the more difficult and slower the motion.*

Now, just as a body — especially an oblong or flat-shaped one, whether it be disc-shaped like an orb, or elliptical, or angular — can be moved and steered in the waters without difficulty, so too [it can be moved] with a still lighter effort in our vaporous air, and most easily of all in the aether. For the thinner and rarer the medium through which that body must be moved or carried, the weaker the resistance, and the less its motion is hindered and retarded. Therefore, since water is denser than the air surrounding the Earth, and the air in turn is somewhat more turbid than the aether itself, that is, than that more remote air, hence a thing passes more easily through the aether and the air than through water, as hardly anyone would readily deny.

[Margin: Faciliùs quid per ætherem aëremq́;,quàm per aquam trajicitur.] *A thing passes more easily through the aether and the air than through water.*

But it now remains to investigate whether a body in the air, just as in water, can be moved and carried directly, or rather at a certain angle of inclination, given an impulse, or a motion that is always straight? We hold that it certainly can. For just as a ship in the waters, with the tiller directed and set along the parallel course of the wind, or of the stream, and then of the length of the vessel, cannot be carried and driven otherwise than continually straight and forward, and by no means obliquely — unless another motion, entirely contrary and resisting, meets it, deflecting the former [motion] from that straight path once taken, as we have shown above at some length — so, assuredly, an oblong body, especially a flat-shaped one, of whatever figure it may be, likewise through the air, given an impulse toward a motion that is recti-

[Margin: Corpus oblongum ſeu diſceum, dato impetu recto, pariter per aërem ac per aquam rectà trajicit.] *An oblong or disc-shaped body, given a straight impulse, passes straight through the air just as through water.*

linear, can be driven continually straight and carried through, provided that this very body is not humped and curved. For even if such a body were driven straight at first by some moving power, it would nevertheless gradually deviate more and more from the straight course, so that it would by no means pass through the air straight toward the point at which its aim was directed: and this should be carefully noted.

[Margin: Corpus gibboſum ſeu incurvatum non fertur in directum.] *A humped or curved body is not carried straight.*

But in what way a straight flat-shaped body, which in your opinion otherwise lacks a tiller, can persist in a constant rectilinear motion is now rightly investigated — the more so since this is the chief question for whose sake we treated all those matters about the motion and steering of ships at such length a little earlier, and also the one on which the whole question of the motion of comets depends. But first I would have you know that every oblong body, especially a flat-shaped one, really has its own rudder, or tiller; according to its direction the body is carried or advances either straight or obliquely, at a certain angle of inclination. This view, I confess, just as it is unusual and has hardly been brought forward by anyone until now, so it will seem strange, indeed almost absurd, to some; and yet (in our judgement) it is not so very discordant, but is even most true, as will shortly be shown more fully.

[Margin: Quodlibet corpus oblongum & planiforme habet temonem ſuum naturalem.] *Every oblong and flat-shaped body has its own natural tiller.*

In the same figure above, T at No. 4, let the parallel lines be the air or aether, in which some body A, flat on both sides but with its thinner side foremost, is to move upward in that diagram. A body of this kind, I say, in such a position and direction, cannot advance otherwise than continually along the course parallel to the lines, with its flat sides, in accordance with the straight impulse impressed on it at the start. This is so for the reason that nature herself has granted that body a tiller, or rudder, by means of which it is here continually steered straight. That is — so that you understand the matter rightly — every flat-shaped body can be compared to a ship fitted with a tiller by which it is steered, in such a way that A *b* is the vessel and likewise also the rudder, namely the other, inner part of the helm; while A *c* is the tiller, which is, as it were, attached and fixed at A, the centre of gravity of that body. Moreover, all flat-shaped bodies, like this one, must be considered in this way: the tiller, that is, the rear part of the body, together with the rudder, namely the front part (which is at the same time equated with the vessel), is so directed and set that it remains continually in one and the same entirely straight line, like a straight flat body, by no means broken or curved in any part. Therefore, as soon as it receives an impulse and motion toward a straight course, it proceeds unceasingly in that direct motion, namely toward the course to which it is driven, so that it can in no way at all be carried otherwise — as we have shown both clearly and at length concerning the rudders of vessels, whether these are considered as levers or as wheels and axles — just like a ship whose tiller and rudder at the stern is directed straight along the ship's length and lashed fast, [and which] is always driven forward along the course of the wind and the impulse, or moving power; unless perhaps, on account of the gravity of its body, it is carried gradually downward toward the centre by a quasi-natural motion, or turns aside because of some other motion supervening, whether external or internal. But on this occasion we exclude these motions entirely from the body to be moved.

[Margin: Res Schemate explicatur.] *The matter is explained by a diagram.*

[Margin: Corpus quodcunq; diſceum, navem temone inſtructum æmulatur.] *Any disc-shaped body imitates a ship fitted with a tiller.*

[Margin: Omne corpus planiforme ſecundùm rectum impetum continuò rectà propemodùm pergit.] *Every flat-shaped body, following a straight impulse, proceeds almost continually straight.*

Since a flat-shaped body is taken here as if it were entirely free of all extraneous motions and subject only to that one straight motion, the question now, I say, is about this body: in what way does it set out on and complete its progress, or its course?

For the sake of greater clarity, however, I think I should briefly repeat once more whatever has already been said about the wind sign, or indicator, set up on the tops of buildings: namely, that a sign or indicator of this kind never comes to rest otherwise than continually along the flow of a sufficiently strong wind. Indeed, if we could in any way take away from it the natural gravity of its body, by which it tends downward toward the centre of the Earth, and it were loosened and freed from the lever on which it hangs, then at once, surely, given an always uniform and constant wind, it would be moved continually forward, straight toward the same course and path, namely under the same direction in which it was at rest at first.

[Margin: In ventorum indicibus ſimilis deprehenditur motus.] *A similar motion is found in wind indicators.*

We see something similar in javelins, darts and arrows shot from a bow: if they are set on the bows straight, and aimed, they too pass straight through the air up to the target set — on this condition, namely, that the impelling motion is entirely uniform and the weight of the material does not draw the arrows down even slightly. But a motion of this kind impressed by the bow continually and gradually decreases (as could be shown at length, if I wished to dwell longer on these matters), and hence the natural gravity of the arrow's body gains strength more and more to exert its tendency and to deviate from the straight path downward toward the Earth. So javelins and arrows, given an impressed impulse of this kind that gradually decreases and fails, can by no means always be carried, or thrown, entirely straight; rather, they must describe by their motion a hyperbolic or a parabolic line.

[Margin: Jacula & ſagittæ, quo motu ferantur.] *By what motion javelins and arrows are carried.*

[Margin: Tela & Sagittæ non continuò in directum pergunt; ſed declinant ſenſim à recto tramite.] *Darts and arrows do not proceed continually straight, but gradually deviate from the straight path.*

But if the motion were continuous and uniform, and we could strip the arrows entirely of all gravity, then certainly arrows and darts would always pass straight through the air: not only because they possess a natural tiller, but also because they are furnished with vanes around their rear end, by means of which they keep to a straighter path. For these vanes, or wings, perform the

office of a tiller directed along the length of a ship, so that the arrows proceed only, and entirely, straight. Moreover, the vanes assist the natural tiller by their breadth: for a rudder that is flat on both sides, and broader as well, does more than a cylindrical and more compressed one; and hence arrows armed with feathers swim through [the air] more straightly than bare ones. For the two vanes that are set, on the bow, along the course parallel to the horizon prevent the arrow from being either raised or lowered with respect to the vertical line; while the other two vanes, upright to the horizon, prevent it from swerving to either side — as can readily be judged from the drawing above at No. 4. For if the upright vanes lean even the least bit obliquely, at once a greater resistance of the air strikes against one or the other of their sides (as tends to happen with a tiller inclined somewhat to the sides), so that the arrow immediately returns to the straight course. You have already grasped this more clearly from the foregoing, so that there is no need at all to pour out more words on this matter.

[Margin: Quâ ratione ſagittæ ſemper motum rectum proſequantur.] *How arrows always keep to a straight motion.*

[Margin: Sagittæ cur plumis inſtruantur ?] *Why are arrows fitted with feathers?*

It is therefore most certain that every flat and straight body, with its thinner side set foremost, if a motion or impulse is impressed on it straight at the start, is carried continually straight — namely while the force, or impelling strength, lasts, and no other contrary motion supervenes from elsewhere: every body, I say, that is flat and straight. For to a curved and bent body the contrary happens entirely, so that it can by no means follow a straight course. For example, in the diagram at No. 4 so often mentioned, those broken bodies, even if they are propelled and thrown at the start with a straight motion, would nevertheless at once advance with a curved and bent motion, receding, namely, from the straight line this way and that, according to the curvature of the body. The reason is clear from the tiller: for when the rudder is inclined to the sides, the ship at once deviates from the course it had taken. It is the same with these curved bodies, which have a tiller as it were inclined and bent: hence such bodies would by no means progress, or be thrown, along an entirely straight path, but along an oblique, indeed a tortuous one. Birds too, with the tail bent, by no means hold a straight flight, but at once, of necessity, reverse their course and fly off elsewhere. In the same way fishes, when they swim with the tail slanted and inclined. For no one is unaware that as soon as a fish bends its tail from the straight line drawn along the length of its body, in a moment the whole body is directed elsewhere, according to the inclination of the tail. So the tails of birds and fishes perform entirely the office of the tillers of ships, while wings and vanes are like oars, which induce or impress motion. Hence I am fully persuaded that the most ingenious and by far the most useful invention of steering and turning ships in every direction by rudders, or tillers, was originally taken from the tails and vanes of fishes; from these the first inventors of ships learned, without any doubt, in what way vessels can be steered by the admirable, indeed never sufficiently praised, rudder. Indeed, they even derived the very

proportion of the helms from the tails of fishes, both the breadth and the length with respect to the body. What more? It does not seem so very discordant [that they] fashioned for themselves the form and figure of the first ship from the body of a fish, which is oblong and, on the lower side, arched, or rather ridged like a keel, but swelling in the middle around the belly, and somewhat more compressed around the head and tail — just as light ships, cargo ships or merchantmen are also usually built — so that the power of the water may strike the more readily against the tiller, or the fish's tail. Let it suffice to have touched on this lightly here.

[Margin: Vniverſa corpora plana & erecta, durante motu recto,continuò in directum;incurvata vero in obliquum feruntur.] *All flat and upright bodies, while the straight motion lasts, are carried continually straight; but curved ones, obliquely.*

[Margin: Cauda avium & piſcium est inſtar temonis.] *The tail of birds and fishes is like a tiller.*

[Margin: Alæ & pinnæ ſunt inſtar remorum.] *Wings and vanes are like oars.*

[Margin: Navium ſtructuram à piſcibus; directionem verò ope gubernaculi, ab ipſorum caudis, pinnisquè depromptam esſe videtur.] *The structure of ships seems to have been drawn from fishes; and their steering, by means of the rudder, from the fishes' own tails and vanes.*

Now at last, to come to the comet, and in conclusion of all the things we have recounted at such length, I argue thus. Since, therefore (as we have shown more than sufficiently), comets are flat-shaped and disc-shaped bodies, like the solar spots, according to axiom 6 of Chapter VII, and they are generated and moved in a most fluid medium, namely the aether (which is nothing but the purest air), then certainly they can assuredly advance in no other way than straight, given a first motion, or straight impulse — namely always entirely toward that region to which the impulse, or strength, propels and throws them; and they can never deflect, or deviate, from that straight course once taken, even though, with terrestrial bodies set in motion, or fired, in the air, something contrary befalls by reason of their weight, or gravity: these, gradually in their progress, on account of their natural heaviness, or propen-

[Margin: Concluditur; dato primo motu recto, Cometas haud aliter quàm motu etiam propemodùm recto trajici posſe.] *It is concluded: given a first straight motion, comets can be carried through in no other way than with a motion that is also almost straight.*

[Margin: Quanquam res terreſtres in tali motu nonnihil à recto curſu deviant.] *Although terrestrial things in such a motion deviate somewhat from the straight course.*

sion, tend and decline toward the Earth more and more, as that motion first impressed, or imparted to it, decreases more and more and vanishes. Since, however, no such heaviness and appetency adheres to comets, which are compounded of an entirely ethereal matter — and if anything of this kind should belong to them by nature, that propensity will without any doubt tend elsewhere, something to be investigated more clearly in its own time — comets

are therefore almost always carried straight through, and borne through the aether: which was to be demonstrated. And yet, if we examine the matter a little more precisely, it will become known from what follows that comets universally are not so very exempt from a certain real deviation with respect to that straight path — not even taking into account the deflection that arises from the confluence, aggregation, resolution and disaggregation of the cometary matter and of its bodies, or nuclei — so that the line of travel which comets describe is partly bent and curved, by reason of the impressed impulse and of the motion of inclination of the disc. But what the genuine reason for this is cannot yet be uncovered here; it is reserved for its own place. It suffices on this occasion to have tasted this matter in passing, so that I may rouse the eager reader all the more, and move his desire to explore all these things the more deeply: for, believe me, as they are profound, so without them very many obscure phenomena could until now neither be detected nor understood.

[Margin: Cometæ duplici deviationi reali ſunt obnoxii.] *Comets are subject to a twofold real deviation.*

[Margin: Linea Cometarum itineraria, non omninò est recta,ſed incurvata, pro motu impreſſo & inclinatione diſci.] *The line of travel of comets is not entirely straight, but curved, according to the impressed motion and the inclination of the disc.*

But while we firmly establish that comets pass straight through that fluid aether (which, however, I do not wish to be taken so very strictly), and on the other hand deny an entirely circular continuous motion, it by no means comes into our mind that comets are carried in a straight line perpendicular to the Earth, according to the opinion of Galileo and of Marius Guiduccius — as if they cut the plane of the ecliptic uniformly and always by a similar path? By no means; rather, that the comets each mark out a particular inclination, or deviation from the ecliptic, and a peculiar and most diverse elevation above the plane of the ecliptic. For some do not touch that plane in any way at all, but leave it far enough away from their orbit, which is inclined in various ways: of which more fully below.

[Margin: An Cometæ ſub lineâ perpendiculari incedant; planumq́; Eclipticæ ſemper ſub certo angulo trajiciant ?] *Whether comets advance along a perpendicular line, and always cross the plane of the ecliptic at a certain angle?*

Although this view may seem very unsuitable, indeed altogether absurd, to most philosophers, especially those devoted to the Peripatetic sect, I am nevertheless compelled, with Kepler (although I dissent from him in many things), to defend with the utmost strength [the view] that comets advance in an almost straight line. There is no reason, however, for you to think that I have been drawn to that view by a lust and itch for novelty; or for the reason that it is a most ingenious and most subtle discovery, namely of detecting the motion of comets along almost straight lines? By no means; rather, love and desire for the truth compelled me to take up this side. I have been most compelled not only by the very many reasons brought forward above here and there, but also by those to be adduced below: above all, since I have properly noticed that

from no other hypothesis can all the phenomena of the comets observed duly and properly up to now — however insoluble they may seem, and altogether wonderful — be explained and demonstrated as happily and fittingly as through the trajectory motion, especially if you suppose the motion of the Earth. For in this way not only the longitudes, latitu-

[Margin: Quare trajectionem Cometarum defendendam Autor ſuſceperit ?] *Why the author has undertaken to defend the trajection of comets?*

[Margin: VniverſaCometarum phænomena hâc datâ hypotheſi omnium optimè demonſtrantur.] *All the phenomena of comets are demonstrated best of all when this hypothesis is granted.*

des and digressions from the Sun, but also their various increases and decreases of motion, their stations and retrogressions, and also those deviations from the straight path around the beginning and the end of the apparition, you will easily explore and come to know.

By contrast, through circular motions — even if, with great difficulty, you save one or two comets in certain respects, such as that of the year 1577 & 1607, especially if one is permitted to assign arbitrarily to the comet in its circle now a faster, now a slower motion, and now even to invent a stationary one without any pressing necessity and reason — nevertheless in the rest, however much you move every stone, it by no means succeeds: just as Tycho himself also found the uniformity of the comet of the year 1577 entirely wanting in the circle he had assumed, as Kepler testifies (*Hyperaspistes*, p. 102). The result is that very many phenomena are left in obscurity, above all if it must be demonstrated how a comet of this kind performs diverse and unequal motions in a circle, with the parallaxes not neglected and the comet's distances on each day attended to at the same time? Moreover, [if it must be] derived from circular motion by what route, as the comet verges toward its heliacal setting, namely around quadrature, it becomes stationary? But through an almost straight motion everything turns out successfully, so that any phenomena whatever, in all comets properly and skilfully observed, cannot fail to be saved in this way — but with the motion of the Earth supposed, as we were just saying: for then everything proceeds in order and fittingly. Indeed, if the matter is examined on a more exact balance, it will be quite plain from what follows to all who by no means cherish a preconceived opinion that from this hypothesis a motion of the Earth is necessarily given, and that all comets fight vigorously for that motion of the Earth. Kepler, too, caught a scent of this long ago. For in the conclusion of Book I, on the history of the comet, he bursts out into these words: *Finally, as many comets as there are, so many arguments are there (besides those drawn from the motions of the planets) that the Earth moves with an annual motion around the Sun. Farewell, Ptolemy; I return to Aristarchus, with Copernicus as my guide.*

[Margin: Quæ verò per circulares motus nullo modo queunt.] *Which, however, cannot by any means [be done] through circular motions.*

[Margin: Cometa 1577 circularem motum planè reſpuit.] *The comet of 1577 utterly rejected circular motion.*

[Margin: Circa trajectiones Cometarũ, etiam motum Terræ ſupponere oportet.] *In the trajections of comets one must also suppose the motion of the Earth.*

[Margin: Omnes & ſinguli Cometæ motum Terræ aſſerunt.] *Each and every comet asserts the motion of the Earth.*

And yet the most learned Riccioli (Book VIII, Section I, Chapter 26 of the *Almagestum*), as also Nicolaus Cabeus, no ordinary philosopher (Book I of the *Meteorologica*, on text 37 of Aristotle, Question VII), hold to the opinion that the rectilinear trajectory motion can be established just as fittingly without the annual motion of the Earth: namely, if you posit that the Sun carries the comet along with it — or rather that line along which the comet is assumed to move — and that in this way the whole planetary system is drawn along with it, with Tycho carrying the torch ahead. They seem to have drawn this view from Kepler, for in the appendix to the *Hyperaspistes*, p. 195, he addresses Sarsius thus: *But to you, Sarsius, if there seems to be any elegance in the straight trajectory, there is no reason why you should not enjoy it in Tycho's dislocatable system as well. For as to the straight trajectory having been propped up by me, in your judgement, with the motion of the Earth: Tycho will prop it up just as firmly with an accompanying systematic motion, which would sweep along even the rectilinear trajectory itself.* To this I too by no means object, provided you grant the dislocatable system. Meanwhile, however, the said Kepler adds in the same place these most notable words, from which one gathers what he thought on this matter, and which should likewise be well noted: *If anyone [has] oak and triple bronze about his breast for believing these things.* And this is entirely most true.

[Margin: Quâ ratione motus trajectorius etiam ſtabilitate Terræ ſalvari poſſit.] *In what way the trajectory motion can be saved even with the Earth at rest.*

[Margin: Quomodo Sol Cometas motu annuo ſecum circumducere poſſit, illæſo prorsùs motu ejus proprio & diurno, haud facilè quisquam capit.] *How the Sun could carry the comets around with it by its annual motion, while leaving its proper and diurnal motion entirely unimpaired, no one easily grasps.*

For here there is need of a prodigious and rare faith, so much so that one must be endowed with an admirable imagination in order to be able to conceive in the mind things plainly impossible: namely, that the Sun can carry around with it, in the most fluid aether, the comet, or its straight line — when that line is only imaginary, and by no means real, nor attached to the Sun by any bonds. This, surely, in our opinion, is much more absurd to conceive in the mind than that the Sun should whirl the planetary system around. For the planets have the Sun as their centre; but as for the trajectory line of the comets, I do not know (to confess the truth) what affinity, or of what kind, it cherishes with the Sun. And yet each of the two seems to me plainly incongruous, and it is much more fitting to grant a motion both annual and diurnal. And so it is indeed easily laid down that the rectilinear motion can be explained through a dislocatable system; but it is grasped by the mind only with great difficulty. Therefore I consider it better to suppose, together with the trajectory motion, that the Earth is moved, as the demonstrations will show to the eye.

But before we set out our view somewhat more clearly — namely, from where this roughly rectilinear motion arises? how it is propagated? whether it proceeds entirely straight, in a direct line, uniformly from its very beginning right up to its extinction? or whether it is curved to some extent in certain places? — and moreover demonstrate fully those most diverse phenomena that occur in the course of the trajection, I think it worth the effort first to bring the comet of the year 1652 to calculation: namely, by inquiring what motion it had, and whether all and each of the things noticed in it can be saved by an almost straight trajectory line? When this has been done, it will likewise not be beside the point to bring other, various comets as well before the eyes of all, with both an accurately drawn diagram and a duly performed calculation: that is, all those comets whose observations, properly carried out, have reached our hands. Of these, however, among so many countless comets recorded by our predecessors, only eight are found (excepting our own of the years 1652 & 1661) that can be of use for this business. Indeed, even among these very few, some are still found from which, for lack of observations, very little is obtained, since in some not even the genuine longitude and latitude has been duly detected and observed — to say nothing of the remaining things of greater moment, extremely necessary for this business. Nevertheless, what we have accomplished in these comets will shortly become clear. Above all, with the help of these nine or ten comets (since no more are extant), it will rightly be demonstrated how, through the trajectory motion, all phenomena whatever that have ever appeared and been recorded can be unravelled and explained in the best way, and fittingly? — by means of one and the same hypothesis in all comets, namely with the Sun placed at the centre of the universe and an annual motion given to the Earth; and indeed for reasons that are not so very absurd, as you will soon perceive. This, surely, as it seems to us, could by no means be done through circular motion, given likewise one and the same unvaried hypothesis: just as I too have spent every effort in this respect to save these ten comets in that way, as to the motion as well as the phenomena; but I have woven a rope out of sand. Whether anyone else will be able to accomplish this very thing, let him make the trial: much indeed

[Margin: Priusquam in hypotheſi noſtrâ progrediamur, conducet Cometam anni 1652 nec non alios quosdam calculo ſubjicere.] *Before we proceed in our hypothesis, it will be useful to subject the comet of the year 1652, and also some others, to calculation.*

[Margin: Quàm paucisſimi Cometæ ritè,& exquiſitè, extent obſervati.] *How very few comets are extant that were duly and exquisitely observed.*

[Margin: Autor operam dedit, ut per circulos, & invariatâ hypotheſi omnes Cometas ſalvaret; ſed fruſtrà.] *The author took pains to save all comets by circles and with an unvaried hypothesis, but in vain.*

of labour he will find, but he will make little headway; even if he derives one or two appearances, he will nevertheless stick fast in very many, and will be forced to leave the greatest part of the phenomena entirely untouched.

To be sure, to describe a trajectory line and to construct some diagram from the calculation is not so paltry a matter; rather, it takes art, and the greatest labour, not only to save all the phenomena duly, but also to determine the path exquisitely, according to the comet's genuine course and motion. Someone will indeed persuade himself that this straight line can be drawn and supposed in any place and position at will, even beneath the very concave of the Moon; but he is deceived in his opinion, and the matter stands far otherwise. For I am entirely certain that you can assign neither to these nine comets nor to any other some straight line, or a section of some great circle, in the air, through which its motion and its phenomena may be rightly preserved and demonstrated. Indeed, not even in the aether itself is that fitting trajectory line so easy to find. It is drawn, I admit, with no trouble at all; but it does not for that reason at once agree exquisitely with the motion of the comet and with all the appearances. Surely, unless you have duly laid the trace [vestigium] and erected the comet's trajectory over it at the proper elevation and inclination [?], always keeping the true distance of the comet from the Earth (which is granted only in a single definite place of the aether), you will labour in vain. For so far [?] is it from being the case that the observed longitudes agree accurately with the latitudes, that rather the one or the other continually deviates a great deal — not to speak of the increases and decreases, and the comet's proper motion, of the time of station, of retrogression [?], and of very many other phenomena, which will always depart enormously from the observation [?] itself.

[Margin: Non res adeò leviuſcula est, Trajectoriam cujuscunq; Cometæ delineare.] *It is not so trifling a matter to delineate the trajectory of any comet whatever.*

[Margin: Nullius Cometæ curſus in aëre rectè demonſtrari potest.] *The course of no comet can be correctly demonstrated in the air.*

For this reason this very thing calls for greater effort than anyone will readily imagine. For whoever undertakes this work will find in practice [?], before he has obtained the genuine position of the trajectory, that the calculation must sometimes be repeated more than ten times, especially by one less practised in this matter. Kepler, indeed, that man of lofty and most acute genius, contributed not a little to this labour, and as it were carried a torch before us in his history of the comets of the years 1607 & 1618 (to whom, on this account too, we owe a very great deal); yet in many things I have followed an entirely different path, and have shortened the calculation not a little, and have also set out each point more clearly (unless my own work pleases me too much). Nevertheless, since the business is in itself very subtle and intricate, I think it will hardly be understood equally readily by all. Hence I urge all who are eager to grasp thoroughly the things to be brought forward [?], as regards both the diagram and the calculation, by no means to survey the whole matter with a fleeting eye, but to weigh the whole business in their minds again and again. For of all the other questions and speculations that ever arise concerning comets, this is the most subtle and most ingenious, and one that no one in the world except

that great Kepler has so far undertaken, or dared to demonstrate in any hairy star. There are indeed some to whom Kepler's rectilinear [?] motion was quite pleasing; meanwhile, however, no one at all has followed in his footsteps, by investigating, that is, whether everything really happens as Kepler would have it.

[Margin: Keplerus,primus ferè omnium motum Cometarum demonſtrare tentavit per lineas rectas; ſed tantùm in Cometis 1607 & 1618.] *Kepler, almost the first of all, tried to demonstrate the motion of comets by straight lines; but only in the comets of 1607 & 1618.*

[Margin: Autor omnes Cometas,quorũ obſervationes exquiſitè fuerunt annotatæ, per rectã Trajectoriam evincere propoſuit, & quidem modo propemodùm compendioſiori.] *The author has set out to establish, by a straight trajectory, all the comets whose observations were exquisitely recorded, and indeed by an almost more concise method.*

For that reason it now falls to us to investigate this matter with all the greater diligence, especially since the author mentioned, in his cometary history, only sketched the comet of the year 1607 & 1618 in the said way and subjected it to calculation; these, however, we shall nevertheless delineate by our own method, together with seven others, without regard to that labour.

Let us begin, then, with our comet of 1652; next let us take up the comet of Regiomontanus, and so the rest in order, those that are at hand, so that we may see how far it is possible to advance with them. Owing to the scarcity of observations, however, on this occasion we shall be able to present in this way only the comets of the year 1472, namely that of Regiomontanus; of 1531 & 1532, those of Appianus; of 1577, 1585 & 1590, those of Tycho Brahe; of 1607 & 1618, those of Kepler; and also our own of 1652. Any others that may perhaps come into our hands hereafter we reserve for Book X or XI, together with the comet of the year 1661, observed faithfully by our own effort not long ago. That we begin with the comet of the year 1652 comes about because we have decided to treat it somewhat more fully and to append its whole calculation. On this occasion it will be possible to place each and every thing clearly before anyone's eyes — above all, how the diagrams must be drawn, and how the calculation must be set up and carried through, in any comet whatever. But of the remaining hairy stars — so that this work, already abundantly stuffed with various numbers, may not grow to an immense size, and so that I may not cause the kind reader nausea with superfluous calculation — we shall present at least the diagrams, and the sum of the calculation in tables, in order and fittingly; so that, if it so pleases you, and it is not irksome, and you shun the labour [?], you may yourself, by exactly that way, subject anything to calculation and examine it. And so I do not doubt at all that you will find everything to have been worked out as accurately as possible, and honestly, and that I have spared myself no labour. But so that our attempt may succeed the more happily, and you may perceive each point better, it will not be beside the point to explain at the outset the diagram itself and its lines for the comet of 1652, since the

delineations of the remaining comets have exactly the same; and then whatever [we say] of this one, we would wish the very same to be said of the others too.

[Margin: Cometa 1652 rigidisſimo calculo, ratione motus Trajectorii, ſubjicitur, quò pateat, quâ viâ incedendum ſit circa reliquos omnes, ſimul Schemata eorum delineari, acTheoria conſtrui debeat.] *The comet of 1652 is subjected to the most rigorous calculation in terms of the trajectory motion, so that it may be clear what way is to be followed for all the rest, and at the same time how their diagrams must be drawn and the theory constructed.*

Let, then, in the accompanying diagram, S be the Sun, as the centre both of the Earth's orbit and of the universe; the circle X A B G the great orb, in which the Earth is moved with its annual motion; the letters X E P A B C etc. indicate the place of the Earth where it stood on the various days. The rays drawn from the Sun S to the Earth are the lines of the eccentric solar longitude. The line X T R K N O is the trajectory plane, or trace of the trajectory, which is always drawn in a plane drawn parallel to the ecliptic; it falls, however, now inside, now outside the great orb, and not rarely even touches it fully, and indeed intersects it, as is clearly evident at X from the attached diagram of the comet of 1652 — although the said trace of the comet, after the twentieth of December, for the whole time of the apparition right up to its very end, proceeded entirely outside the Earth's orbit. Next, the line a b c i is the comet's trajectory itself, which mostly intersects the trace at a certain angle, so that it is partly raised above it and partly depressed below it. Hence, as long as the comet is southern, the said trajectory lies hidden beneath the trace; but when it becomes northern, it rises above it. Let there be, then, in the attached figure, a b c d e f g etc.

[Margin: Elucidatio Schematis Cometæ 1652.] *Elucidation of the diagram of the comet of 1652.*

[Margin: Trajectoria ſub certo angulo pleruṅq; veſtigium interſecat.] *The trajectory mostly intersects the trace at a certain angle.*

Diagram. A full-page engraved plate, with no text on the page, titled in the upper right *Theoria Cometæ anno 1652 à Joh. Hevelio obſervati.*, "Theory of the comet of the year 1652, observed by Joh. Hevelius." In the main figure, filling the upper two-thirds of the plate, straight rays fan out from the Sun at the lower left to an arc of the Earth's annual orb, which crosses the plate from left to right; each point of the arc is lettered and dated. From each point of the arc a line of sight runs up to the right. A long diagonal line, the trace of the trajectory, descends from the upper left to the right-hand end of the arc at X; the lines of sight cut it at lettered points. From X the arc of the orb and the trace run on together down to the right, and the ray from the Sun to X is labelled as the eccentric line of solar longitude. A further line, the trajectory, runs down to the right from near that ray; lower down, in the part numbered 2, it crosses a horizontal line, the trace, lettered at the feet of dotted perpendiculars, with the northern latitudes marked above the trace and the southern below. Below this, in the part numbered 3, a horizontal trace line carries upright lines of latitude; and in the part numbered 4, a circle with a vertical diameter carries

a set of lines joining points on its circumference to two points on the diameter. The labels engraved on the plate:

- *Theoria Cometæ anno 1652 à Joh. Hevelio obſervati.* (upper right): Theory of the comet of the year 1652, observed by Joh. Hevelius.
- *Vestigium Trajectoriæ.* (along the diagonal line at the upper left, reading downward): Trace of the trajectory.
- *Linea Viſoria.* (twice, along two lines of sight above the lettered points) and *Linea Viſoria* (upright, along a third): Line of sight.
- O, N, M, L, K, I, H, R, T (where the lines of sight cut the trace, from upper left to lower right).
- G, F, E, D, C, B, A, P, Q, X (along the arc of the orb, from left to right; X at its right-hand end, where it meets the trace).
- 8, 5, *Januar.* 2, 30, 26, 23, 20, 17, 14 *Decembr.* (the dates on the rays under G, F, E, D, C, B, A, P and Q in turn): 8, 5, January 2, 30, 26, 23, 20, 17, December 14.
- *Orbis annuus Terræ.* (along the arc beyond X): The annual orb of the Earth.
- *Vestigium Trajectoriæ.* (along the trace beyond X): Trace of the trajectory.
- *Linea Eccentrica Longitudinis Solaris.* (along the ray from the Sun to X, reading upward): Eccentric line of solar longitude.
- *Trajectoria* (at the upper end of the descending line) … *Cometæ.* (at its lower end, below the part numbered 2): Trajectory of the comet.
- Part 2: *2.*; h, g, f, e (on the trajectory above the trace) and c, b, a (below it); *Latitudo Borealis.* (upright, beside the first dotted perpendicular): Northern latitude; *Vestigium* (at the left end of the horizontal line) … *Trajector.* (at its right end): Trace of the trajector[y]; O (the first letter of the row; capital or lower case not settled), N, M, L, K, I, H, R, T (above the trace); m (eight times) and d (below the trace, d where the trajectory crosses it); *Latitud.Austr.* (upright, beside the last dotted perpendicular): Southern latitude.
- Part 3: *3.*; g, f, e (at the tops of three uprights); *Latitud.* (twice, beside the first two uprights): Latitude; M, E, L, D, K, C (on the horizontal line) and B (at its right end); *Vestigium lineæ Trajectoriæ.* (below the line): Trace of the trajectory line; B (below M, at the head of a line running down to T of part 4).
- Part 4: *4.*; G and T (on the circumference, at the left); C and S (on the diameter).
- *S Sol.* (at the foot of the rays, lower left): S, the Sun.
- *Fig. V.* (lower left): Fig. V.
- *Autor ſculpsit.* (lower right, in script): Engraved by the author.

the comet on the various days on which it appeared; and the perpendicular lines running from the trajectory, from the comet to the trace, its various latitudes. And so let T R H I K L etc. represent the points of the perpendiculars, or of the latitudes, falling on the trace; these describe, as it were, the proper

daily motion in the said trace, in the same way as that motion itself is expressed in the trajectory at *a b c d e* etc. Further, through each of those points of the trace, lines of sight of the comet's apparent longitude have again been drawn from the Earth itself, all necessarily running toward the plane of the ecliptic. Thus in this example of ours A H is the line of sight of 20 December, namely of the first apparition (so that in all the following diagrams the line of sight A is the earlier one); B I is the one that belongs to 23 December; and so on in sequence. The lines from the Earth to the trajectory, such as Q T, P R etc., represent the distance of the perpendicular from the centre of the Earth; X Q and X P the subtenses [ſubtenſas] of the Earth's motion from the intersection X; and likewise X T and X R etc. the distances of the perpendicular from the intersection X, that is, [the intersection] of the annual orb and the trajectory trace.

The angles that occur in these delineations are the following. 1. The angle X I B, and X K C: the motion of the comet from 9 December (for on this day the trace of this comet passed through the great orb). 2. The angle S X O, S Q T, S P R etc.: the elongation of the comet from the Sun. 3. The angle X B I, X C K, X D L etc.: the angle of the lines of sight with the subtense of the Earth's motion. 4. The angle X T Q, X R P, X H A etc.: the angle of the trajectory trace with the lines of sight of the comet's longitudes. 5. The angle X S Q, X S P, X S A: the motion of the Earth from the intersection of the annual orb and the trajectory trace. 6. T X Q, R X P, H X A etc.: the angle of the trajectory trace with the subtenses of the Earth's motion. Finally, I would also have you note that when the comet is less than a quadrant away from the Sun as seen, the comet is then said to be in the Sun's hemisphere.

[Margin: Quinam anguli Schemati inſerviant.] *Which angles serve the diagram.*

[Margin: Quando Cometa in hemiſphærio Solis exiſtat.] *When the comet is in the Sun's hemisphere.*

But to come to the matter itself, let us now indicate briefly, and supply definite rules, how the position of the trajectory of comets in this hypothesis must be explored and determined, both mechanically and by calculation; and so, finally, let us write out the whole calculation as succinctly as can ever be done. I judge, however, that a table must first be set out exhibiting the subtenses of the Earth's motion in the eccentric, according to our hypothesis, with the radius of the Earth's annual orb taken as 5157 semidiameters of the Earth and the horizontal parallax of the Sun as 40″; and also the various angles necessary for the operation.

For the calculation, moreover, the comet's longitudes of 23, 26 and 30 December, and also of 2 January, and its latitudes of 23 and 30 December, were taken; from these the lines of the trajection [Lineæ Trajectionis] were afterwards deduced by the hypothesis. In this deduction you may note that the trajectory trace cuts the Earth's annual orb at ♊ 18° 30′, and that with the line of sight of 26 December it makes an angle of 100° 45′; and so, from the Earth on

9 December, it appears to tend toward ♏ 5° 9′; and finally that the trajectory makes with its trace, above the plane of the ecliptic, an angle of 43° 30′.

[Margin: Quibus datis calculus Cometæ 1652 nitatur.] *On what data the calculation of the comet of 1652 rests.*

First, there must be ready to hand both the longitude and the latitude of the comet observed on several days, and the longitude of the Sun, and from these the elongation of the comet from the Sun, or conversely of the Sun from the comet. It will, however, be most convenient … the place of the Su-

[Margin: De ſitu Trajectoriæ Cometarum determinando.] *On determining the position of the trajectory of comets.*

n and the opposite [place] of the Earth in the eccentric, or [the place] merely by the physical equation [Æquationem duntaxat Phyſicam], to employ here. For in this way only the mean distance of the Earth from the Sun is needed, no account being taken of the eccentricity; and yet with exactly the same effect as would follow if the true longitude of the Sun and its true distance from the Earth were used, as will become evident below.

2. With the radius of the Earth's annual orb, let an arc of that orb be described, as large as seems sufficient for determining on it the various places of the Earth at the intervals of four, five or more days at which the comet was seen and observed.
3. From the designated places of the Earth, let there be drawn out, on the one hand toward the centre of the annual orb, the indicators of the eccentric solar longitude, and on the other hand other lines, which make with the former angles equal to the elongation of the comet from the Sun, and so represent the lines of sight of the comet's apparent longitude.
4. These very lines of sight of the longitudes, by their meetings and mutual intersections, appear to reveal, not obscurely, roughly where the trajectory of the comet finds its place, such that its daily portions are either equal or increase or decrease in regular order. Thus the lines of the longitudes of the comet seen in the year 1652, in the preceding diagram, are clear proof that it could have passed only in the vicinity of the Earth, below all their intersections, since between or above those intersections of the lines of sight it finds everywhere a tangled and back-and-forth path.

[Margin: Lineæ viſoriæ & latitudines manifeſt[[e/è]] indicant ductum Trajectoriæ.] *The lines of sight and the latitudes clearly indicate the course of the trajectory.*

5. A more accurate, and finally the true, position of the trajectory is, however, defined when the latitudes of the comet are brought in. To this end four days are taken, separated by as great an interval as possible and distinguished by the most exact observations of the comet; and on some straight line four angles are constructed equal to the observed latitudes of those very days. In constructing the theory of the comet of 1652, account was taken chiefly of 23, 26, 30 December and 2 January, whose latitudes

are expressed by the angles I B *d*, K C *e*, L D *f*, M E *g* in the diagram shown.

6. Now, then, on the plane of the ecliptic, among those lines of sight of the comet's longitude, let the trace of the trajectory be drawn (the trajectory, as I have already mentioned above, for the most part always runs oblique to the plane of the ecliptic) in whatever way is perhaps judged most convenient; and let the same trace be drawn separately, with those four points at which it intersects the lines of sight of the days taken (here I, K, L, M), other straight perpendicular lines also being drawn through those intersections.

[Margin: Trajectoria pleruńq; planum Eclipticæ interſecat.] *The trajectory mostly intersects the plane of the ecliptic.*

7. On the straight line to which the latitude angles [Anguli Latitudinarii] of the days taken were applied, let straight perpendicular lines be erected, subtending those four angles of latitude, at as great a distance as the intersections I, K, L, M are distant from the corresponding places of the Earth B, C, D, E. These straight lines represent the heights of the perpendiculars let fall from the comet onto its trace on the plane of the ecliptic.
8. Hence, if these heights are duly applied to the perpendiculars drawn through the trace drawn separately, and one straight line can pass through the ends of these four heights, the position of the trajectory has been correctly found. If not, that trajectory trace must be bent and moved this way and that, until the heights of the perpendiculars, subtended to the latitude angles at the due distance, reach with their ends into one straight line in the way described.

[Margin: Vnde conſtet, Trajectoriam rectè eſſe delineatam.] *How it may be established that the trajectory has been correctly drawn.*

9. Once the position of the trajectory has been found by this mechanical method, it must be examined by calculation and limited until no hope remains of a better one, more convenient for saving the appearances. The method of calculation, however, is somewhat different when the trajectory trace (extended too, if need be) touches or cuts the Earth's annual orb, and when it passes it by untouched.

[Margin: Diverſa ratio eſt, quando veſtigium orb⟦c/e⟧m annuum tangit, atq́; cùm intactum eum r⟦c/e⟧linquit.] *The method is different when the trace touches the annual orb [?], and when it leaves [?] it untouched.*

10. First, when the case arises, let there be measured, in the diagram in which the position of the trajectory has been constructed mechanically, the arc of the annual orb intercepted between the place of the Earth on some day taken and that intersection X. If this arc is added to or subtracted from the Sun's apparent longitude on the same day taken, as the case requires, it gives the place of the Sun at the time when the Earth occupies that opposite point of the intersection.

11. Let there likewise be measured the angle of the trajectory with the line of sight of one day taken, which determines, namely, the motion of the comet's longitude between the time taken and the time at which the Earth is at the intersection X and has the same line of sight as the trajectory. This angle, added or subtracted as the case requires to the comet's longitude on the said day taken, shows the longitude at which the comet would then appear, when the Earth was at the intersection X; for brevity's sake we may call this the longitude of the trajectory.

[Margin: Quid ſit longitudo Trajectoriæ.] *What the longitude of the trajectory is.*

12. Once the longitude of the trajectory is known, its elongation from the Sun is easily found; and likewise the angle that the line of sight of any day makes with the trajectory trace, namely the difference of those apparent longitudes.
13. The motion of the Sun, or rather of the Earth, between any two of its places is the angle at the centre of the annual orb, X S B, X S C, etc. The complement to a quadrant of half this angle is X B S or B X S, C X S or X C S: namely, the angle that the radius of the annual orb makes with the subtense of the Earth's motion, since each of these triangles is isosceles.
14. These angles B X S, C X S, D X S etc., subtracted from the elongation of the trajectory from the Sun, S X M, leave the angles of the same trajectory with the subtenses of the Earth's motion between the intersection X and the places of the remaining days, namely B X I, C X K, D X L etc. And the angles X B S, X C S, X D S (each equal to the corresponding one of the former), subtracted from the elongation of the comet from the Sun on the corresponding days, S B I, S C K, S E L etc., leave the angles of the former subtenses with the lines of sight of the comet's longitude, for as many days as are wanted: X B I, X C K, X D L, etc.
15. The subtenses of the Earth's motion themselves, between any two places, are found without difficulty in the isosceles triangle X S B, X S C etc., from the known angle at the vertex and either leg. For as the whole sine is to the sine of half the angle, or the radius of the annual orb to half the subtense. Since, however, these subtenses would have to be changed in many ways for constructing the various theories of different comets, it was worth the effort to construct, on the foundation just stated, a small table of these subtenses for all the quadrants, and indeed for the degrees of the semicircle; this table afterwards gave more readily the subtenses wanted, for any number of degrees.

[Margin: Quâ ratione ſubtenſæ motus Terræ ſupputentur.] *How the subtenses of the Earth's motion are computed.*

16. And these are roughly the things that follow immediately, and of their own accord, from the longitude of the Sun and of the comet and from the hypothesis adopted, which that table, set before the calculation of

the comet of the year 1652, exhibits; from these the rest is deduced by reasoning with triangles.

17. Here, however, it also seems that we should briefly show what was supposed at the beginning: namely, that the eccentric place of the Sun can be used in place of the true one without any difference in the calculation. For in the diagram above, 4 of Fig. V, p. 593, let S be the Sun, C the centre of the eccentric annual orb, S C the eccentricity, and T and G two places of the Earth on the eccentric (which, for this purpose, can be taken in place of the ellipse itself without any risk, or even the least risk, of error). Then T C and G C will be the lines of the eccentric place of the Sun, and T S and G S the lines of the true place of the Sun. Let T B also be the line of sight of some comet; hence S T B is its elongation from the true place of the Sun, and B T C its elongation from the eccentric place of the Sun [?]. Now it seems plain that only the same subtense T G can be found, whether in the triangle T C G or in T S G; and that the angle G T B, of the subtense with the line of sight, will be the same whether C T G is subtracted from C T B or S T G from S T B.

[Margin: Locus Solis Eccentricus,pro vero, ſine ullo aberrandi periculo adhiberi poteſt.] *The eccentric place of the Sun can be employed in place of the true without any risk of going astray.*

18. Now further, in the triangle X B I, in the same diagram just mentioned, with one side X B known (the subtense of the Earth's motion) and all the angles, the remaining sides X I and I B (of the trace and of the annual orb) are sought from the perpendicular let fall from the comet onto the trace; that is, the distance of that perpendicular from the corresponding place of the Earth. And the method is the same for the remaining triangles X C K, X D L, X E M.

19. Next, from the four days taken, two are chosen; the latitudes of the comet observed on them, together with the intervals of the Earth from the perpendiculars from the comet, yield the heights of those perpendiculars. For in the right-angled triangle D L *f*, as the whole sine is to the tangent of the latitude L D *f*, so is the interval D L to the height L *f*. The same is also to be judged of the triangle B I *d*.

[Margin: Quomodo perpendiculorum altitudines inveniantur.] *How the heights of the perpendiculars are found.*

20. The distance of the intersection X from the perpendicular from the comet on either of these days, if it is subtracted from the like distances of the remaining days, gives the trajectory motion of the comet over its trace between that same day and the remaining days.

21. Of the two heights that were found a little earlier, the difference is taken if they tend in the same direction, the sum if in different directions. This quantity, together with the trajectory motion between the same days, serves to find the angle that the trajectory itself makes with the plane of

the ecliptic [?]. For in the right-angled triangle *d m f*, as *d m* is to *m f*, so is the whole sine to the tangent of the obliquity sought, *f d m*.

[Margin: Ratio inv[[c/e]]niendi Angulum Trajectoriæ & Plano Eclipticæ.]
The method of finding [?] the angle of the trajectory and the plane of the ecliptic.

22. From this angle of obliquity and the trajectory motion between the earlier day and any other day, the increment or decrement of the perpendiculars from the comet is found, and consequently their height itself. For as the whole sine is to the tangent of the obliquity, so is the trajectory motion to the increment or decrement; this, added to or subtracted from the height of the earlier day, produces the height of the perpendicular for any day.
23. Finally, in another right-angled triangle, from the height of the perpendicular and its distance from the Earth, as the two legs of the right angle, the latitude of the comet itself for the same day is sought.
24. Having thus supposed two latitudes for two days, the latitudes for two other days are sought by the method described above. If these agree with the observed ones, the hypothesis adopted and the position of the trajectory are true. But if they disagree, the intersection X of the annual orb and of the trajectory trace, and likewise the angle of the trajectory with one line of sight, must be changed and varied until, with two latitudes supposed, the remaining two follow from the hypothesis in agreement with the observations.

[Margin: Ex latitudinibus cognoſcitur, an ſitus Trajectoriæ verus ſit ?] *From the latitudes it is learned whether the position of the trajectory is true?*

25. When this method of calculation had been repeated very often, through a great many trials, the position of the trajectory best suited to saving the appearances of the comet of the year 1652 was found to be such as the theoretical table [Tabula Theorica] of that comet shows below, in its place. Nevertheless the longitudes and latitudes of the days taken themselves also had to be changed in part, since otherwise this comet would have seemed to reject the laws of rectilinear trajection altogether. Especially on those days on which the comet was not visible to us, and the observations were not so certain. Yet that change was made within very few minutes, which is easily excused among experts. For it is not possible for the motions of a phenomenon of that kind to be distributed so exactly to any day and hour, as has been done in our ephemeris, from which these motions were taken, unless they are observed carefully and continuously from day to day.
26. Finally, once the hypothesis and theory of the comet have been established from the observations of four days, then, so that it may be applied to the remaining days as well, the trajectory motion of the comet between each of the successive days taken must be considered: namely, whether it increases or decreases. For if the proper ratio of that increment or decrement is kept, that motion can be extended to any other days, forward and backward. From this it will then be easy to assign the trajectory

motion of the comet, both from the intersection X of the annual orb and from that other day whose latitude was assumed, to any remaining days; of these, the former serves chiefly for finding the longitude of the comet, the latter for finding its latitude, from the hypothesis adopted. The comet that was seen in the year 1652 advanced over its trace 172 semidiameters of the Earth between 23 and 26 December; 222 semidiameters of the Earth between 26 and 30 December; 161 semidiameters of the Earth between 30 and 2 January. Its motion therefore decreased. For in the first three days it advanced 57⅓ semidiameters of the Earth daily, in the middle four days 55½, and in the last three days 53⅔ semidiameters of the Earth, if the intervals of these motions are divided into equal segments. From this ratio of decrease, then, the trajectory motion of that comet on its trace was continued from 14 December up to 8 January, both from the intersection X of the annual orb and from the trace of the comet at 23 December, on this side and beyond, or forward and backward.

[Margin: Quantus fuerit motus diurnus Cometæ 1652 ſuper ſuo veſtigio.] *How great the daily motion of the comet of 1652 over its trace was.*

27. Accordingly, for each day for which the longitude and latitude of the comet are to be computed from the hypothesis, a triangle is given, for example in the year 1652, December 20, A X H. In it two sides are known: A X, the subtense of the Earth's motion, and H X, the distance of the perpendicular from the intersection X of the annual orb; together with the included angle A X H of the subtense with the trajectory. From these, first, the angle A H X is sought, which the line of sight of that day makes with the trajectory; and this angle is itself also the motion of the comet between the longitude of the trajectory and the desired place of the comet on the proposed day, which is then easily revealed by subtracting or adding that angle to the longitude of the trajectory.

[Margin: Pro intervallo perpendiculi ex Cometâ à Terrâ.] *For the interval between the Earth and the perpendicular from the comet.*

28. Next, in the same triangle A X H, the side A H is sought: the interval between the centre of the Earth and the perpendicular from the comet. For as the sine of the angle A H X is to the opposite side A X, so is the sine of the angle A X H to the opposite side A H. And by this same method both the longitude of the comet and the interval of the perpendicular from the Earth are sought for any other day.

29. To find the latitude, however, one proceeds here by no other way than the one taken to find the latitude of the two days assumed earlier. For here too, from the trajectory motion between 23 December and from the angle of obliquity of the trajectory, the variation of the height of the perpendiculars is sought, and consequently their height itself, and from that, further, the apparent latitude of the comet.

[Margin: Pro inquirendo motu vero in Trajectoriâ obliquâ.] *For finding the true motion on the oblique trajectory.*

30. It now remains to find, for each and every day, the interval of the comet itself from the centre of the Earth, and its true motion on its oblique trajectory. The interval is found in the right-angled triangle, for example A H *c*, from the known latitude angle H A *c* and the side A H, the interval of the perpendicular from the Earth. The same is to be held for the remaining triangles B I *d*, C K *e*, etc.
31. Finally, as the sine of the complement of the obliquity of the trajectory is to the trajectory motion on the trace between any two days, so is the whole sine to the true motion of the comet on its oblique trajectory between the same days.

By this method we have now not only drawn the diagram of the comet of 1652 and worked out its calculation, but also [those] of all the subsequent comets; and following its lead you will be able to investigate others too, if any appear hereafter and are duly observed. But so that no one may fail to understand all the better each of the things just said, let us add here the whole calculation of this comet of 1652, as a clear example.

Calculation for the Theory of the Comet Seen in the Years 1652 and 1653 [Calculus pro Theoriâ Cometæ Anno 1652 & 1653. visi.]

A small table showing various angles, which are derived immediately from the known longitude of the Sun and of the comet and are required for the rest of the calculation, together with the subtenses of the motions of the Earth in its great orb.

Dec.	Comet's longitude observed	Comet's latitude observed	Motion of the comet from 9 Dec.	Sun's eccentric longitude	Motion of the Earth from 9 Dec.	Complements of half the Earth's motion	Elongation of the comet from the Sun	Angle of the lines of sight with the subtenses of the motion of ♁	Angle of the trajectory with the subtenses of the motion of ♁	Complements of these angles	Subtense of the Earth's motion (Sem. T.)
9	5ˢ 5° 9′			8ˢ 18° 30′		0′	103° 21′				
14				8ˢ 24° 9′	5° 30′	87° 15′			16° 6′	163° 54′	495
17				8ˢ 27° 8′	8° 30′	85° 45′			17° 36′	162° 24′	765
20				9ˢ 0° 0′	11° 30′	84° 15′	.		19° 6′	160° 54′	1034
23	1ˢ 29° 31° 35′ *A.*		96° 6′	9ˢ 3° 1′	14° 31′	82° 44′	146° 2′	63° 18′	20° 36′	159° 24′	1303
26	1ˢ 24° 24° 4′ *B.*		100° 45′	9ˢ 6° 2′	17° 32′	81° 14′	138° 22′	57° 8′	22° 7′	157° 53′	1571
30	1ˢ 21° 21° 0′ *B.*		103° 48′	9ˢ 10° 3′	21° 33′	79° 14′	131° 18′	52° 5′	24° 7′	155° 52′	1927
Januar. 2	1ˢ 20° 17° 52′ *B.*		104° 52′	9ˢ 13° 3′	24° 33′	77° 43′	127° 14′	49° 31′	25° 38′	154° 22′	2193
5				9ˢ 16° 4′	27° 34′	76° 13′			27° 8′	152° 52′	2457
8				9ˢ 19° 5′	30° 35′	74° 42′			28° 39′	151° 21′	2721
			XIB		XSQ	SXQ	SXO	XBI	TXQ		XQ

Dec.	Comet's longitude observed	Comet's latitude observed	Motion of the comet from 9 Dec.	Sun's eccentric longitude	Motion of the Earth from 9 Dec.	Complements of half the Earth's motion	Elongation of the comet from the Sun	Angle of the lines of sight with the subtenses of the motion of ♁	Angle of the trajectory with the subtenses of the motion of ♁	Complements of these angles	Subtense of the Earth's motion (Sem. T.)
			XKC		XSP	SXP	SQT	XCK	RXP		XP
			XLD		XSA	SXA	SPR	XDL	HXA		XA
			&c.		*&c.*	*&c.*	*&c.*	*&c.*	*&c.*		*&c.*

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December 23 [Decemb. XXIII.]
semidiameters of the Earth 1303 X B · *logarithm* 203793
96° 6′ X I B · *logarithm* 568 *S.*
Proport. 203,225
63° 18′ X B I · *logarithm* 11275 *A.*
1171 X I · *logarithm* 214500
20° 36′ B X I · *logarithm* 104457
Proport. 203,225 *A.*
461 B I · *logarithm* 307682
1° 35′ south latitude · *mesologarithm* 358844 *A.*
13 I *d* · *logarithm* 666526
361 L *f*
374 *m f* · *logarithm* 328608
394 I L · *logarithm* 323399 *S.*
43° 30½′ obliquity of the trajectory · *mesologarithm* 5209 —+ *antilogarithm* 32122
461 B I · *logarithm* 307682
1° 35′ latitude · *antilogarithm* 38 *S.*
461 B *d* · *logarithm* 307644
December 30 [Decemb. XXX.]
semidiameters of the Earth 1927 X D · *logarithm* 164662

590 The table is framed and ruled, with twelve columns. The first column carries no head; its unit line reads Dec., and the January rows carry the word Januar. set sideways beside the days 2, 5 and 8. Each quantity is given here in one column; the page sets its signs, degrees and minutes as separate figures under the unit heads S. Gr. M. (or S. G. M.), Gr. Min., Gr. M. and Gr. Mi., and the last column under Sem. T. (semidiameters of the Earth). A. and B. after the latitudes stand as printed. In the row for 9 December the sixth and seventh columns print only a 0 under the minute head; in the row for 20 December the elongation column prints only a point. Horizontal rules divide the rows for 9 to 20 December, 23 to 30 December and 2 to 8 January, and divide these from the four foot rows, which carry the plate letters naming the angle or line that each column gives for successive days, followed by &c.; the second, third, fifth and eleventh columns and the day column carry no foot letters. The symbol ♁ in the heads is the sign of the Earth.

108° 48′ X L D · *logarithm* 2929 *S.*
Proport. 161,733
52° 5′ X D L · *logarithm* 23711 *A.*
1565 X L · *logarithm* 185444
S. 1171 X I
394 I L
24° 7′ D X L · *logarithm* 89503
Proport. 161,733 *A.*
811 D L · *logarithm* 251236
24° 0′ north latitude · *mesologarithm* 80917 *A.*
361 L *f* · *logarithm* 332153
811 D L · *logarithm* 251236
24° 0′ latitude · *antilogarithm* 9042 *S.*
888 D *f* · *logarithm* 242194
394 I L · *logarithm* 323399
obliquity · *antilogarithm* 32122 *S.*
544 *d f* · *logarithm* 291277
December 26 [Decembr. XXVI.]
semidiameters of the Earth 1571 X C · *logarithm* 185087
100° 45′ X K C · *logarithm* 1770 *S.*
Proport. 183,317
57° 8′ X C K · *logarithm* 17443 *A.*
1343 X K · *logarithm* 200760
S. 1171 X I
172 I K
22° 7′ C X K · *logarithm* 97685
Proport. 183,317 *A.*
602 C K · *logarithm* 281002
172 I K · *logarithm* 406285
obliquity · *mesologarithm* 5209 *A.*
163 *m e* · *logarithm* 411494
S. 13 *m* K
150 K *e* · *logarithm* 419971
602 C K · *logarithm* 281002 *S.*
13° 59′ latitude *B.* · *mesologarithm* 138969 —+
602 C K · *logarithm* 281002
13° 59′ latitude · *antilogarithm* 3008 *S.*
620 C *e* · *logarithm* 277994
172 I K · *logarithm* 406285
obliquity · *antilogarithm* 32122 *S.*
237 *d e* · *logarithm* 374163
January 2 [Januar. II.]
semidiameters of the Earth 2193 X E · *logarithm* 151730
104° 52′ X M E · *logarithm* 3405 *S.*

Proport. 148,325
49° 31′ X E M · *logarithm* 27365 *A.*
1726 X M · *logarithm* 175690
S. 1171 X I
555 I M
25° 37′ E X M · *logarithm* 83852
Proport. 148,325 *A.*
981 E M · *logarithm* 232177
555 I M · *logarithm* 289137
obliquity · *mesologarithm* 5209 *A.*
527 *m g* · *logarithm* 294346
S. 13 *m* M
514 M *g* · *logarithm* 296812
981 E M · *logarithm* 232177 *S.*
27° 40′ latitude *B.* · *mesologarithm* 64635 —+
981 E M · *logarithm* 232177
27° 40′ latitude · *antilogarithm* 12142 *S.*
1108 E *g* · *logarithm* 220035
555 I M · *logarithm* 289137
obliquity · *antilogarithm* 32122 *S.*
765 *d g* · *logarithm* 257015[591]

Amount of the trajectory on the plane of the ecliptic [Quantitas Trajectionis ſuper Plano Eclipticæ.]

	From the intersection of the orbits of the Earth and the comet	Differences	From 23 December
December 14	567 X T		604 I T
		225 T R	
17	792 X R		379 I R
		198 R H	
20	990 X A		181 I A
		181 H I	
23	1171 X I		0
		172 I K	
26	1343 X K		172 I K
		222 K *L*	

[591] The calculation is printed in two columns and two tiers: December 23 (left) and December 30 (right) above, December 26 (left) and January 2 (right) below; each block is given here in turn. On each line the left group (an angle, or a length in semidiameters of the Earth, with the plate letters that name it, or a label) and the right group (the logarithm) stand side by side on the page; they are separated here by a raised point. Angles printed as a degree figure with a point followed by the minutes are set in degrees and minutes. *Proport.*, *S.*, *A.* and the latitude letter *B.* stand as printed; the mark —+ after three mesologarithms is printed. The short rules under figures that are added or subtracted, the rules dividing the steps, and the heavy rule between the two tiers are not reproduced.

	From the intersection of the orbits of the Earth and the comet	Differences	From 23 December
30	1565 X L		394 I *L*
		161 L M	
January 2	1726 X M		555 I M
		158 M N	
5	1884 X N		713 I N
		156 N O	
8	2040 X O		869 I O

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December 20 [Decembr. XX.]
1034 X A
990 X H
44 difference · *logarithm* 542615
2024 sum · *logarithm* 159749 *S.*
160° 54′ complement of A X H · 382,866 —+
80° 27′ half · *mesologarithm* 178236 — *A.*
A. 7° 22′ angle of difference · *mesologarithm* 204630 —+
87° 49′ X H A
S. 2^{s} 27° 49′
5^{s} 5° 9′ longitude of the trajectory
♊ 7° 20′ longitude of the comet
19° 6′ A X H · *logarithm* 111713
1034 X A · *logarithm* 226916 *A.*
338,629
87° 49′ X H A · *logarithm* 73 *S.*
339 A H · *logarithm* 338556
181 I H · *logarithm* 401181
obliquity · *mesologarithm* 5209 *A.*
172 *c m* · *logarithm* 406390
13 *m g*
185 H *c* · *logarithm* 398998
339 A H · *logarithm* 338556 *S.*
28° 39′ south latitude · *mesologarithm* 60442 —+
339 A H · *logarithm* 338556
28° 29′ latitude · *antilogarithm* 13060 *S.*
386 A *c* · *logarithm* 325496
181 I H · *logarithm* 401181
obliquity · *antilogarithm* 32122 *S.*
250 *c d* · *logarithm* 369059

[592] On the page the differences stand between the rows they divide, at half-line offsets; here each has a row of its own. The first column has no head. The L of two cells is set in a different italic form and is shown in italics.

December 17 [Decemb. XVII.]
765 X P
792 X R
27 difference · *logarithm* 591450
1557 sum · *logarithm* 185982 *S.*
162° 24′ complement of P X R · 405,468 —+
81° 12′ half · *mesologarithm* 186557 — *A.*
S. 6° 23′ angle of difference · *mesologarithm* 218911 —+
74° 49′ X R P
S. 2^{s} 14° 49′
5^{s} 5° 9′ longitude of the trajectory
♊ 20° 20′ longitude of the comet
17° 36′ P X R · *logarithm* 119610
765 X P · *logarithm* 257046 *A.*
376,656
74° 49′ X R P · *logarithm* 3553 *S.*
240 P R · *logarithm* 373103
379 I R · *logarithm* 327280
obliquity · *mesologarithm* 5209 *A.*
360 *b m* · *logarithm* 332489
13 *m* R
373 R *b* · *logarithm* 328876
240 P R · *logarithm* 373103 *S.*
57° 17′ south latitude · *mesologarithm* 44227 —
240 P R · *logarithm* 373103
57° 27′ latitude · *antilogarithm* 61529 *S.*
443 P *b* · *logarithm* 311574
379 I R · *logarithm* 327280
obliquity · *antilogarithm* 32122 *S.*
522 *b d* · *logarithm* 295158
December 14 [Decemb. XIV.]
495 X Q
567 X T
72 difference · *logarithm* 493367
1062 sum · *logarithm* 224244 *S.*
163° 54′ complement of Q X T · 269,123 —+
81° 57′ half · *mesologarithm* 195594 — *A.*
S 25° 37′ angle of difference · *mesologarithm* 73529 —+
56° 20′ X T Q
S. 1^{s} 26° 20′
5^{s} 5° 9′ longitude of the trajectory
♋ 8° 49′ longitude of the comet
16° 6′ Q X T · *logarithm* 128260
495 X T · *logarithm* 300578 *A.*

428,838
56° 20′ X T Q · *logarithm* 18359 *S.*
165 Q T · *logarithm* 410479
604 I T · *logarithm* 280667
obliquity · *mesologarithm* 5209 *A.*
573 *m a* · *logarithm* 285876
A. 13 *m* T
586 T *a* · *logarithm* 283702
165 Q T · *logarithm* 410479 *S.*
74° 17′ south latitude · *mesologarithm* 126775 —
165 Q T · *logarithm* 410479
74° 17′ south latitude · *antilogarithm* 130608 *S.*
609 Q *a* · *logarithm* 279871
604 I T · *logarithm* 280677
obliquity · *antilogarithm* 32122 *S.*
833 *a d* · *logarithm* 248555[593]
January 5 [Januar. V.]
2457 X F
1884 X N
573 difference · *logarithm* 285945
4341 sum · *logarithm* 83448 *S.*
152° 52′ complement of F X N · 202,497 —+
76° 26′ half · *mesologarithm* 142167 — *A.*
A. 28° 41′ angle of difference · *mesologarithm* 60330 —+
105° 7′ X N F
S. 3^{s} 15° 7′
5^{s} 5° 9′ longitude of the trajectory
♉ 20° 2′ longitude of the comet
27° 8′ F X N · *logarithm* 78512
2457 X F · *logarithm* 140363 *A.*
218,875
105° 7′ X N F · *logarithm* 3522 *S.*
1161 F N · *logarithm* 215353
713 I N · *logarithm* 264086
obliquity · *mesologarithm* 5209 *A.*
677 *m h* · *logarithm* 269295

[593] Below the table the calculation is printed in two columns and two tiers: December 20 fills the upper tier, running from the left column into the right; December 17 (left) and the last block (right) fill the lower tier. On each line the left group and the right group (the logarithm) stand side by side on the page and are separated here by a raised point. *S.* and *A.* stand as printed where a figure is subtracted or added; *S.* before a value in signs marks it as subtracted from the longitude of the trajectory below it. The marks —+ and — after logarithms are printed. Before the *A.* of the seventh line of December 20 stands a small angular mark that is not resolved. The rules dividing the steps are not reproduced.

13 *m* N
664 N *h* · *logarithm* 271206
1161 F N · *logarithm* 215353 *S.*
29° 47′ north latitude · *mesologarithm* 55853 —+
1161 F N · *logarithm* 215353
29° 47′ latitude · *antilogarithm* 14167 *S.*
1337 F *h* · *logarithm* 201186
713 I N · *logarithm* 264086
obliquity · *antilogarithm* 32122 *S.*
983 *d h* · *logarithm* 231964
January 8 [Januar. VIII.]
2721 X G
2040 X O
681 difference · *logarithm* 268678
4761 sum · *logarithm* 74213 *S.*
151° 22′ complement of G X O · 194,465 —+
75° 41′ half · *mesologarithm* 136568 — *A.*
A. 29° 16′ angle of difference · *mesologarithm* 57897 —+
104° 57′ X O G
S. 3^{s} 14° 57′
5^{s} 5° 9′ longitude of the trajectory
♉ 20° 12′ longitude of the comet
28° 38′ G X O · *logarithm* 73563
2721 X G · *logarithm* 130158 *A.*
203,721
104° 57′ X O G · *logarithm* 3443 *S.*
1350 G O · *logarithm* 200278
869 I O · *logarithm* 244300
obliquity · *mesologarithm* 5209 *A.*
852 *m i* · *logarithm* 249509
13 *m* O
812 O *i* · *logarithm* 251081
1350 G O · *logarithm* 200278 *S.*
31° 2′ north latitude · *mesologarithm* 50803 —+
1350 G O · *logarithm* 200278
31° 2′ latitude · *antilogarithm* 15447 *S.*
1575 G *i* · *logarithm* 184831
869 I O · *logarithm* 244300
obliquity · *antilogarithm* 32122 *S.*

1198 *d i · logarithm* 212178[594]

And so I have discharged what I had promised about the comet of 1652. It now seems right that I go on to the comet observed by Regiomontanus in the year 1472, as the older of those that follow. [Margin: Cometam àRegiomontano obſervatum, plurimi arbitrati ſunt, in ipſo aëre extitisſe.] *Very many thought that the comet observed by Regiomontanus existed in the air itself.* Many have said many things about it, as though it had made quite enormous advances and most immoderate leaps; and from this they came to the opinion that it stayed in the sublunary air itself, indeed close to the Earth itself. But whether the matter was entirely so or not, we shall soon see. [Margin: Ex omnibus ritè obſervatis Cometis commonſtratur, Trajectoriam propemodùm dari rectam.] *From all properly observed comets it is shown that the trajectory is very nearly a straight line.* Above all, it will be clearly established, both from this comet and from all the remaining comets that follow, that the undertaking has turned out happily for us; that by a single fixed theory and a trajectory line we can save any phenomena of comets whatever; and that for that reason not only is this hypothesis to be embraced in preference to the others, as more suited to all the appearances and more consonant with reason, but also this speculation has given us occasion, and supplied the strength, for detecting and penetrating very many sublime and extremely abstruse matters: especially how matters stand with the comet's first rising and the force of its motion; what kind of trajectory it has; whether it proceeds entirely in a straight line without any deviation, or is curved, and how. After this, what curvature the path line [linea itineraria] has: whether it comes from a spherical section or a conic one; whether elliptical, parabolic or rather hyperbolic; whether all comets [have] plainly the same, similar [trajectory], or each obtains a trajectory of its own; whether their motion decreases continually, and then when and how; and very many other most profound questions of this kind, which will be brought forward and discussed in their place below. [Margin: Quænam hoc Libro diſcutiendæ ſint quæſtiones.] *Which questions are to be discussed in this Book.*

But to come to the matter itself, I think it must first be pointed out that for the investigation and calculation of this comet of 1472, whose summary we have shown in the annexed small table, the longitudes of the comet of January 13, 20 and 22, and likewise of February 13 and 27, were used, and the latitudes of January 22 and February 13. [Margin: Quibus datis calculus Cometæ anno 1472 fulciatur.] *On what data the calculation of the comet of the year 1472 rests.* And so the comet's trajectory trace [veſtigium] cuts the annual orbit of the Earth in ♌ 10° 12′, the Sun then being in ♒ 10° 12′. The same [trace] runs under the

[594] The calculation is printed in two columns, January 5 on the left and January 8 on the right; each block is given here in turn. On each line the left group and the right group (the logarithm) stand side by side on the page and are separated here by a raised point. *S.* and *A.* stand as printed where a figure is subtracted or added; *S.* before a value in signs marks it as subtracted from the longitude of the trajectory below it. The marks —+ and — after logarithms are printed. The rules dividing the steps are not reproduced.

ecliptic toward ♊ 15° 0′. The angle of the trajectory itself with its trace on the plane of the ecliptic makes 3° 8′.

The order of this table set beside it, which gives the summary of the calculation, is as follows (we shall keep it not only for this comet but also for all the remaining comets that follow). [Margin: Ordo,quem Autor tam in hujus, quam ſubſequentium Cometarum Tabellis ſervavit.] *The order which the author kept in the tables both of this comet and of the comets that follow.* The first small column gives the month and the day on which the comet was observed; the second and third, the observed longitude and latitude; the fourth and fifth, the longitude and latitude of the comet deduced from the hypothesis; the sixth, the eccentric longitude of the Sun; the seventh, the elongation of the comet from the Sun; the eighth, the distance from the Earth of the perpendicular [let fall] from the comet on to the trace; the ninth, the distance of the same perpendicular from the intersection of the annual orbit and the trajectory; the tenth, the altitude of the perpendicular; the eleventh, the true motion of the comet in its trajectory; the twelfth, the interval of the comet from the centre of the Earth; the thirteenth, the apparent motion of the comet in its course.

	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)	Apparent motion of the comet in its course (deg. min.)
January and February	In the year 1472											
January 13			14° 0′ ♎	8° 56′ B.	1° 16′ ♒	52° 44′	581	340	91	0	588	
20			10° 0′	34° 45′	8° 16′	241° 48′	112	94	76	247	137	26° 5′
21			0° 39′	56° 23′	9° 16′	231° 23′	51	55	76	39	91	22° 31′
22			5° 0′ ♊	75° 0′ B.	10° 16′ ♓	4° 44′	20	15	73	40	76	42° 4′
23			29° 38′ ♋	43° 11′	11° 16′	78° 22′	93	26	71	41	104	35° 36′
30			19° 46′	6° 39′	18° 16′	61° 33′	452	366	53	341	455	37° 34′
February 6			17° 53′ ♌	2° 15′ B.	25° 15′ ♈	38′	737	800	29	435	738	4° 47′

	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)	Apparent motion of the comet in its course (deg. min.)
13			16° 0′	0° 0′	2° 14′ ♓	43° 46′	927	1326	0	527	927	2° 56′
20			13° 46′	1° 51′ A.	9° 12′	34° 34′	1022	1930	33	605	1022	2° 54′
27			11° 0′	3° 54′	16° 8′	24° 52′	1026	2599	70	670	1029	3° 27′

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Diagram. A full-page engraved plate, with no text on the page, titled at the top *Theoria Cometæ Anno 1472 à Regiomontano obſervati.*, "Theory of the comet observed by Regiomontanus in the year 1472." In the upper figure, which fills the upper two-thirds of the plate, an arc runs across from the lower left and on down to the right, with lettered points along it. Three lines descend from the upper left, each labelled with a longitude, and meet near the middle, where two lines rise to the upper right, each also labelled. From the lettered points of the arc a set of parallel lines runs down to the right, each ending in a longitude in Aries, and a line of points runs down to the left from the crossing near K; dotted lines descend from the points of the arc and converge below, each marked with a date. A line labelled *Trajectoria.* rises from the lower left to g. In the lower figure, two lines descend from the left, two lines rise to the right through lettered points, and a horizontal line runs from C to B; dotted lines converge at S, with a longitude in Aquarius beside it. A second *Trajectoria.* rises from the lower left through K. At the foot, two long nearly horizontal lines cross the

595 The table has no title. It is ruled in thirteen columns across the lower part of the page; the first column has no head, and the units are printed in a row of their own under the heads (Gr. M. or Gr. Mi., degrees and minutes; Sem.T., semidiameters of the Earth), given here in brackets after each head. The row for January and February 1472 spans the table as printed. The month words are printed sideways in the first column, January beside the days 13, 20 and 21 and February beside the four February days; the days 22, 23 and 30 of January have no month word beside them. The columns for the observed longitude and latitude are blank in every row, and the apparent motion is blank for January 13. Signs of the zodiac stand as printed, only where the page prints one; B. (borealis, north) and A. (australis, south) stand as printed after the latitudes. A rule under the figure 15 in the ninth column, between the rows of January 22 and 23, is not reproduced.

plate, with letters at the feet of short dotted uprights. The labels engraved on the plate:

- *Theoria Cometæ Anno 1472 à Regiomontano obſervati.* (title, top centre): Theory of the comet observed by Regiomontanus in the year 1472.
- Upper figure, the three lines from the upper left: ♍ 29° 47′; ♎ 7° 0′; 13[?] 30′ ♎.
- Upper figure, the two lines rising to the upper right: *Trajectoria.*, Trajectory; 30° 0′. ♊, with an unlabelled dot near the end of the line.
- Upper figure, near the central crossing: H, C [?], I, K.
- Upper figure, on the arc from right to left: A, with ♌ beyond it; D; E; ♍; F; G; g; ♎ (rotated, at the lower left of the arc).
- Upper figure, on the line of points running down to the left: L, M, N, O, o.
- Upper figure, dates beside the dotted lines: *13 Januar.*, January 13 (from A); 20; 23; 30 (from D); 6; 13; 20; *27 Febr*, February 27.
- Upper figure, at the right-hand ends of the parallel lines, from top to bottom: ♈ 24° 58′; ♈ 14° 11′; 13 18′ ♈; ♈ 12° 40′; ♈ 11° 52′; ♈ 10° 58′.
- Upper figure, along the line rising from the lower left: *Trajectoria.*, Trajectory.
- Lower figure, the two lines from the left: ♍ 29° 47′; ♎ 7° 0′.
- Lower figure, the points on the rising lines: I, R, T, Q, with ♊ 3° 0′ along the second line.
- Lower figure, the horizontal line: C (left end), X, P, B (right end); K below X.
- Lower figure: *Trajectoria.*, Trajectory (along the line rising from the lower left); S, at the foot of the converging dotted lines, with ♒ 1° 55′ beside it; ♈ 24° 58′, along a long line below.
- Foot of the plate, from left to right: o, O, N, M, L, K, I, H.
- *Fig. W.* (lower left): Fig. W.
- *Autor ſculpsit.* (lower right): Engraved by the author.

Now that the small table giving the principal heads of the calculation has been set out in this way, let us first weigh and examine, as is fitting, whether a trajectory motion can suitably be ascribed to this comet too, and then what deserves to be noted here. [Margin: An Cometa 1472, motum ſuum in Trajectoriâ abſolverit?] *Whether the comet of 1472 completed its motion in a trajectory?* This haired star was observed by the most celebrated Johannes de Monte Regio, otherwise called Regiomontanus. As a philosopher much devoted to the Peripatetic sect, he was persuaded, together with many others, that this comet had been very close to the Earth, and so sublunary: above all because it had a parallax of 6 degrees, and had performed an astonishing, anomalous and wandering motion (as he had conjectured, indeed believed). [Margin: Spatio 24 horarum 40 gr. in ſuâ ſemitâ peregit; undè Regiomontan⁹ ipſi parallaxin 6 gr. aſſignavit.] *In the space of 24 hours it travelled 40 degrees on its path; from which Regiomontanus assigned it a parallax of 6 degrees.* For in the space of 24 hours it had covered

40 degrees on a great circle, even though around the beginning and the end of its appearance its motion was very slow, even according to Regiomontanus himself. His observation was handed down to us by Antonius Myzaldus, in the last chapter of Book I of *Com.*, from Jacobo Zieglero [Jakob Ziegler], as is clear from our History of Comets.

But since we have proposed, with God's help, to discuss the motion of this comet somewhat more fully, it will greatly help, I think, for the sake of better understanding, if we briefly set down here the very history of this comet that Regiomontanus left us, so that you may first read through each and every point attentively, and weigh for yourself on what foundation we rest.

[Margin: Hiſtoria Cometæ àRegiomontano obſervati anno 1472.] *History of the comet observed by Regiomontanus in the year 1472.* "On the Ides of January," he says, "in the year of the Lord one thousand four hundred and seventy-five, a comet was seen by us under Libra, with the stars of Virgo. Its head was of slow motion until it came near Spica; now it was advancing through the legs of Boötes, toward his left. Moving away from there, in one natural day it described a portion of a great circle of forty degrees. When it was in the middle of Cancer, it stood at its greatest distance from the circle of the signs, seventy-seven degrees; and now it went between the two poles, of the zodiac and of the equinoctial, as far as the space between the feet of Cepheus; then through the breast of Cassiopeia, above the belly of Andromeda. Afterwards, proceeding along the length of the northern Fish, where its motion slackened greatly, it approached the zodiac, crossing it near the middle of Aries, until, together with the stars of Cetus, its heliacal setting hid it from us in the last days of February. [Margin: Prodigioſus Cometæ motus.] *The prodigious motion of the comet.* By this proper motion of its own it described a portion of a great circle, along which it was carried to the north and, with this, against the succession of the signs, from Libra into Aries. At the end and at the beginning it moved slowly, but in the middle of its appearance very swiftly: in one day through almost four signs, from the end of Virgo all the way to the beginning of Gemini. And according to the nature that must be ascribed to it, it ought to have continued its motion until it had returned into Libra and appeared [there] again; and perhaps it did move in that way, since at its setting it was still of great size. Yet because of its configuration with respect to the Sun, and especially in the northern regions, it could [poterit] scarcely be seen at the end of its appearance, except toward the south in the days of April, if it had kept the regularity of its motion. [Margin: Caudæ motus, locus & inclinatio.] *The motion, place and inclination of the tail.* Its tail, however, being less mobile, went round the stars of Gemini, continually facing them, never turning away from them during the whole time of its appearance. And so at its first emergence the comet stretched its tail toward the west, since the stars of Gemini were reckoned to be there. But at the end, when the comet was placed under Aries, because of the nearness of the Sun it did not appear except in the west, with its tail stretched toward the east, since in this situation the stars of Gemini were placed [there]. In the

middle of its appearance, however, it turned its tail toward the south: there at that time were the stars of Gemini; and it then happened, in the same night, that immediately after sunset the tail faced the east. As midnight approached it faced the south, and after midnight the west. Before sunrise it pointed to the region of the north. [Margin: Mirus Cometæ motus & planè C[[æ/œ]]leſtis.] *The marvellous and wholly celestial motion of the comet.* This variety in the position of the tail arose from the diurnal motion, which always runs, following the primum mobile, from east to west. By its proper motion, however, the end of the tail moved from the beginning of Libra as far as the middle of Taurus: more slowly than the head of the comet, yet always westward too, against the succession of the signs, describing a parallel. It went under the feet of the Howler [Ululans], through the Great Bear, approaching Perseus; and through him, around the Pleiades, it went to the tail of Aries, almost in the middle of Taurus. From this it is clear that both the head and the tail of the comet went toward the west, and never toward the east: not only by the diurnal motion, but also by the proper motion." Thus far Regiomontanus, through the diligence of Jac. Ziegler, who did not disdain to impart this history of the comet together with his own conceptions on Genesis.

[Margin: Obſervatio Cometæ 1472 à Regiomontano peracta, atq́; ex Vranodromo Com. Crügeri deſcripta.] *The observation of the comet of 1472 made by Regiomontanus, and copied from Crüger's* Uranodromus Com[eticus]. To this P. Crüger adds the following in his *Uranodromus Comet[icus]*, chapter 14, page 87: namely, the later part of the same observation of Regiomontanus. But I do not know where he drew it from, since he cited neither book nor author. However that may be, he writes: "He writes further (that is, Regiomontanus): 'Those who know the principles of geometry and arithmetic will by no means disagree with what is held from the teachings of Ptolemy, by which he demonstrated in the *Almagest* that the concave [surface] of the orb of the Moon is only 33 times as far from the centre of the Earth as it is from the same centre to the surface of the Earth. The semidiameter of the Earth (as can be gathered) contains about 913 German miles, and by it (as Alfraganus [al-Farghānī] says in *differentia* 23) we reckon the distances of the stars from the Earth. [Margin: Quantam Parallaxin Cometa poſſederit, ex mente Regiomontani.] *How great a parallax the comet had, in Regiomontanus's opinion.* Consider, then, the greatest parallax of the comet's head from Spica, the star near it, which, as far as was possible, with all irregularities reduced, could not be found greater than 6 degrees, with suitable instruments set up for this. From this parallax it necessarily follows that the body of the comet stood off from the surface of the Earth at a ninefold distance in relation to the semidiameter of the Earth, which is at least 8200 miles; and it was placed in the upper part of the highest region of the air, and not in the fire, assuming a tenfold quantity in the commensuration of the elements, as the Philosopher determined in 2 *On Generation*.' And these alone (says Crüger) are whatever Regiomontanus noted on this matter."

[Margin: Quo anno Cometa Regiomontani reverà apparuerit.] *In which year Regiomontanus's comet really appeared.* To begin with, it must be noted about this comet that some authors refer it to the year of Christ 1472, and others again to the year 1475 (as Myzaldus does). But although it matters very little to us in what year this phenomenon really shone, provided only that we have a genuine description of it, I nevertheless have no doubt at all that it appeared in the year 1472. Pet. Crüger, it is true, in the *Uranod[romus] Comet[icus]*, as also in various letters sent to Kepler in the year 1623, holds that the same comet was seen in the year 1475; but he was led astray by certain writers, as Kepler sufficiently showed in the *Hyperasp[istes]*, Book III, Chapter XVII. Above all, [Kepler] demonstrates still more fully, in a certain letter to Crüger written at Linz on the day before the great conjunction in the year 1623, that this comet certainly shone in the sky in the year 1472. Since this letter is at hand to us, and not yet published, it does indeed deserve to be added here; but, to avoid prolixity, it is reserved for another time, together with other letters. So no further doubt now remains about that year, 1472, in which it blazed forth.

[Margin: Ex obſervationibus Regiomontani verus locus Cometæ anni 1472 minimè conſtat.] *From Regiomontanus's observations the true place of the comet of the year 1472 is by no means established.* For the rest, however, it would be most earnestly to be wished that the genuine observations of the same author (if he took any from the sky itself) had also been attached to this description of the comet by Regiomontanus, so that one could investigate the true place of the comet belonging to each day; but nothing whatever about them has come to our knowledge. Crüger, it is true, wove something more onto this observation of Regiomontanus; nevertheless, whatever it may be, nothing about the true place of this comet is established for us from those [additions] either, in whatever way he may have said that the phenomenon had a parallax of 6 degrees. For it is entirely hidden from me where and by what route he derived that parallax, that is, from which observations and data. I am therefore almost of the opinion that it flowed entirely from nothing but a preconceived Aristotelian opinion that he seized on so great a parallax, and then computed, or rather conjectured, the distance from it. But, however little I may be going astray, let us nevertheless leave all this standing as it is for the present, and proceed with our purpose.

[Margin: Jam olim nonnulli operam dederunt, ut Cometæ hujus curſus in æthere conſervaretur.] *Some long ago took pains that this comet's course should be preserved in the aether.* It is indeed a hard matter, and one of great labour, to obtain and elicit anything certain, whether by some diagram or by calculation, since no accurate longitudes, nor latitudes, indeed not a single exact place on any day, are given. Nevertheless many most excellent men long ago laboured strenuously over how its motion, so excessive (in the opinion of the Peripatetics), could be carried out and saved even in the highest aether. Peter Crüger, a man of rare learning, strives to preserve it under a great circle; [Margin: Quatenus Crügerus Cometam iſtam defendat.] *How far Crüger defends this comet.* but only

to this extent, as can be read in Chapter XIII, page 78, of the *Uranod[romus] Comet[icus]*: that those 40 degrees that it traversed in one day are to be taken and counted not at all in its own orbit, but as having been completed according to the longitude of the ecliptic. For at about that time the comet was carried not far from the pole of the ecliptic, so that this opinion is not altogether absurd. In my judgement, however, the said author seems to do some violence to the observation itself. For Regiomontanus's words convey the matter quite otherwise, and are clear in themselves, as is evident from his account above: "Now," he says, "it was advancing through the legs of Boötes toward his left; moving away from there, in one natural day it described a portion of a great circle of 40 degrees." He adds besides: [Margin: Cometa uno die 4 Signa ſecundùm longitudinem emenſus eſt.] *In one day the comet measured out 4 signs in longitude.* "At the end and at the beginning it moved slowly; in [?] the middle very swiftly, in one day through 4 signs, from the end of ♏ all the way to the beginning of Gemini." So I have no doubt at all that this comet traversed 40 degrees in the space of 24 hours, and that in the path of a great circle, and four whole signs in longitude.

[Margin: Autor demonſtrare proponit, Cometam potuiſſe ſub circulo maximo in Trajectoriâ moveri; non obſtante motu ejus apparente incompoſito.] *The author proposes to demonstrate that the comet could have moved under a great circle in a trajectory, notwithstanding its irregular apparent motion.* Kepler, however, a man of keen discernment [Vir emunctæ naris], comes nearer the mark in the *Hyperaspistes*, Book III, Chapter XVII, by assuming a more fitting hypothesis, namely by maintaining the motion of comets along a straight line, or trajectory; and he demonstrates with sufficient reasons that this comet too could have advanced in a straight line in that way. But since everything brought forward there is somewhat obscure and intricate (for the author's words rest on no diagram), I wished, concerning this hairy star too, by means of some diagram, the mi- nd of ours — to lay it open, and to demonstrate duly by calculation that this comet could indeed have made such enormous and disordered advances, and nevertheless appear under very nearly a great circle, while at the same time being carried through the aether.

[Margin: Quo fundamento calculus hujus Cometæ nitatur.] *On what foundation the calculation of this comet rests.* First: from the observation and history of that comet it is abundantly clear that at the beginning the comet had a northern latitude, not very great, and at the end, in turn, a southern one. As for the longitudes, since none at all were recorded, they must be determined according to the sense of the history and according to the fixed stars it names, so that every phenomenon can be explained and saved. [Margin: Quâ ratione tales enormes ſaltus Cometa peragere potuiſſet, ex Theoriâ & Schemate clarè demonſtratur.] *How the comet could have made such enormous leaps is clearly demonstrated from the theory and the diagram.* Accordingly, as is evident from the preceding table of this comet of 1472, I assumed its latitude at the beginning, on January 13, as 8° 56′ north; on January 22 as 75° north; and about its last appearance, namely

on February 27, as 3° 54′ south. The longitudes, as the same table attests, we set out according to the fixed stars, as I was just saying. In this way the whole matter is now saved, and we can uphold quite consistently, by a trajectory line, all the phenomena of that comet — phenomena which seem almost to surpass the grasp of every intellect, even the keenest. This holds provided that the said trajectory is assumed to advance above the great orb and its plane, but removed from them by a short interval, and to cut the great orb in ♌ 10° 12′, the Sun being then in ♒ 10° 12′. And so the trace (as I was saying a little before) runs under the ecliptic toward ♊ 15° 0′, and the angle of the trajectory itself with its trace, above the plane of the ecliptic, is 3° 0′ (by reason of the assumed latitudes), given, that is, the intersection of the trajectory [?] and the plane of the ecliptic at N; so that there the comet, below the plane of the ecliptic, acquires a southern latitude, namely on February 13.

Further, so that the trajectory or trace (as is established from the earlier figure of this phenomenon) H, I, K, L, M, N, O, etc., inclines little by little more and more toward the Sun S, and the comet itself tends from H toward O — in this way, I say, the Earth on January 13 stands at A, while the comet in turn was observed at H in ♎ 13°; that is, according to the observation itself, near the stars of Virgo. [Margin: Quomodo Cometa uno die ex Virgine in Geminos,motu retrogrado trajccerit.] *How the comet passed in one day from Virgo into Gemini with a retrograde motion.* As the Earth proceeds, however, and is placed at B on January 20, the comet stood nearer the plane of the ecliptic, at I; at that place, of necessity, it then appeared retrograde with respect to longitude, and in ♎ 7°. On January 21 the comet, approaching both the plane of the ecliptic and the Earth, which was at P, was seen at R, that is, in ♍ 29° 47′. But when the Earth, between January 21 and 22, had crossed the trace and passed under the comet's trajectory near X, toward Q on the other side of the trace, being then in the other segment of the great orb, that hairy star after a very short space of time necessarily presented itself to view no longer in ♍, but in the entirely opposite region of the sky, in about ♊ 3°. As to why the comet had to be seen from the other part of the hemisphere, the reason is this: at that time the Earth had advanced under the trajectory from B toward Q. Hence between the 21st and the 22nd that phenomenon showed spectators clearly that it had traversed so immense a space of the sky, and that very swiftly — namely four signs of the zodiac in its orbit, from the beginning of ♎ all the way to the beginning of ♊, with a retrograde motion, as the observations themselves require. [Margin: Quâ die velocisſimum illum motum exhibucrit.] *On which day it displayed that very swift motion.* For Regiomontanus, about the middle of that swift motion, saw the comet's body almost in ♋, with a greatest latitude of 77 degrees. From this it is gathered again that the said author reckoned the speed of that motion from the morning, and that this very swift motion was thus accomplished between the 21st and the 22nd. This very point seems to agree with the account in the Chronological Compilation [Compilationis Chronologicæ], where it is noted that this comet, sighted after the Feast of

the Epiphany, increased its motion remarkably once eight days had passed. The same is likewise inferred from Walther's observations: he recorded that he saw the comet on January 20, near the left shoulder of Boötes, at 10^h after noon. Hence it is probable, as we have already said, that the comet was so swift between the 21st and the 22nd. This is now likewise clear from the preceding diagram W, assigned to this phenomenon, and from the calculation presented: namely, that from January 13 to the 22nd no more than eight days elapsed. But after the Earth reached C on January 23, the comet, in its retrograde motion and along the path K toward the Sun, was thus seen then in ♈ 25°; but [it was seen] to advance with a somewhat slackened motion, both in the ecliptic and in its orbit — the former from the lines of sight, the latter from the calculation, as can no longer be hidden from anyone.

[Margin: Quando phænomena ſtationem celebrare videantur.] *When the phenomena seem to make a station.* When the Earth, however, on the course it had undertaken, arrived at D and E — namely on January 30 — the comet at L and M is nevertheless found to be much slower in appearance, indeed almost stationary (although in its orbit it in fact advances with an equally swift motion, not to say one still not a little swifter [?]). For the [lines] of sight [?] drawn from the Earth through the comet now approach a parallel course, where phenomena always make a station, according to Theorem II, to be set out below in its place. The comet therefore remained in Aries from January 23 right to the end [?]; it completed scarcely half of that sign. [Margin: Quando Eclipticam transiverit.] *When it crossed the ecliptic.* For about the middle of ♈ it crossed the ecliptic in turn and acquired a southern latitude; and so finally, a little later, about the last [day] of February, it was entirely extinguished in about ♈ 10°, as the very words of Regiomontanus, from Ziegler, plainly indicate: "Afterwards," he says, "proceeding along the length of the northern Fish, where its motion slackened greatly, it approached the zodiac, crossing it near the middle [?] of Aries, until the heliacal setting with the stars of Cetus hid it from us in the last [?] days of February."

[Margin: Per noſtram Theoriam,tam motus qu[[à/ä]]m reliqua phænomena univerſa hujus Cometæ 1472 optimè ſalvantur.] *By our theory both the motion and all the other phenomena of this comet of 1472 are saved excellently.* But for the sake of greater clarity let us survey the whole observation and [?] compare it with this hypothesis of ours. I do not doubt that each and every [?] thing recorded about this comet can be upheld and saved excellently and fittingly — which assuredly could never be done by any other theory, much less if it had lingered in the sublunary air. For if it had advanced constantly in the air [?] far below the Moon, I grant that the extraordinarily swift [?] [motion] of that one day could indeed be preserved; but how, I ask, will you reconcile the very slow motion before and after, and that continuously under the same segment of a great circle — to say nothing of very many other appearances?

[Margin: Quo loco Cometa 40 grad. in ſuâ orbitâ peragraverit.] *In what place the comet traversed 40 degrees in its orbit.* First, Regiomontanus reports that

on January 13 the comet was seen near the stars of Virgo, and was slow as long as it was near Spica and consequently the remaining [?] stars of Virgo; but after it had ascended to the left of Boötes, it then measured out 40 degrees of a great circle with a very rapid [?] motion, to the space between the feet of Cepheus. This, from our diagram and calculation, as above we have already touch- ed on, is also rightly demonstrated. Second: "In the middle of Cancer," says the author, "it had a northern latitude of 77°; afterwards it passed between the two poles, namely that of the zodiac and that of the ecliptic, and so through the breast of Cassiopeia and the belly of Andromeda." And that by its own motion it described a portion of a great circle, and then in the north was carried from ♎ into ♈ against the order of the signs [contra ſ. ſ.]. At the end and at the beginning it moved slowly, in the middle very swiftly, in one day through 4 signs, from the end of Virgo all the way to the beginning of Gemini. These things likewise correspond exactly to our hypothesis and calculation.

[Margin: Totodurationis tempore caudam ad Stellas Geminorum projecit.] *For the whole time of its duration it cast its tail toward the stars of Gemini.* Third: what is asserted about its tail — namely that it was not at all mobile, continually facing the stars of Gemini and going round them, and never departing from them during the whole time of the appearance — and other things of this kind, that the coma stretched toward the west at the beginning, toward the south in the middle of its path, and toward the east at its exit: this too follows, by pressing necessity, from our theory and the given trajectory line. Indeed, you will perceive all that has been put forward almost more clearly still if you picture for yourself on an artificial celestial globe, and draw there, the said diagram, the position of the comet and the place of the Sun: namely, that in each and every respect, according to the account of the history, things in fact turned out exactly so, and not otherwise than [they follow] from the hypothesis.

[Margin: Quali capite, & quantâ caudâ fulſerit Cometa 1472.] *With what kind of head and how great a tail the comet of 1472 shone.* Pontanus adds, moreover, about this comet that at its first rising it had a thin head and a short coma, and that with its motion it increased that size remarkably, so that [the coma] was seen to be 50 degrees long. Our theory too upholds this appearance. For at the beginning, on January 13, with the comet at H, it stood removed from the Earth (as the calculation and the table show) by 588 semidiameters of the Earth; on the 21st, however, by only 91; and on the 22nd it was removed from it by a still smaller interval, namely 76 semidiameters of the Earth. Hence at the beginning the head certainly appeared much smaller than on the 21st and 22nd, being, as it were, at a greater distance and under a smaller angle of vision.

[Margin: Quare caput à principio, & in fine minus, quàm tempore interme- dio deprehenſum fuerit.] *Why the head was found smaller at the beginning and at the end than in the intervening time.* I add that perhaps the head itself also grew in bulk from day to day at that time, as usually happens in comets. But after it went farther from the Earth day by day — namely from January 30, toward M, N, O, etc. — it was again found to be altogether smaller; for about that

time, according to our hypothesis, the comet was removed from us to 700, 800, and indeed on February 27 to more than 1000 semidiameters of the Earth. For granted that on January 13, at a distance of 588 semidiameters of the Earth, it appeared only 2′ in diameter, yet on the 21st, when it was removed from the Earth by only 91 semidiameters, it would necessarily have appeared more than 12 [′] in the size of its head; and if the diameter of the head had been twice as great, namely 4′, then at that nearer distance it would have been seen as 24′. This is indeed a very evident discrepancy, and on that account it struck the eyes of all spectators as strongly as possible; so that it becomes clear again and again, in favour of our theory too, that the comet shone with a thin head at the beginning and at the end, but with a very large one about the middle of its appearance.

[Margin: Admiranda caudæ longitudo quorundam Cometarum.] *The wonderful length of the tail of certain comets.* For this reason the tail itself could also certainly appear about 50 degrees [long] at that shorter distance; just as a similar length of coma is not so unusual in other comets either, especially when they approach the Earth. For that very many of that kind have been very long, our History of Comets, toward the end of this work, abundantly testifies; and in Book VIII, too, it was shown at length that some of them have at times extended to 40°, 50°, 60°, 70°, and even further, to a quarter of the sky.

[Margin: Vt ut inæqualis motus hujus Cometæ apparuit, ſummè tamen regularis & proportionatus extitit.] *However unequal the motion of this comet appeared, it was nevertheless supremely regular and proportionate.* But the chief and most wonderful of those appearances is that its proper daily motion was found to be so excessively unequal: very slow, that is, on the first and the last days, but about the middle of its path very swift, at almost 40 degrees; whereas this proper motion along its track was in truth supremely proportionate, regular, and steadily increasing. [Margin: Motus diurnus verus quotidi[[e/è]] decrevit.] *The true daily motion decreased every day.* For at the beginning it advanced only 33 semidiameters of the Earth each day; afterwards, about the Earth, on January 21 and 22, 39 and 40 semidiameters of the Earth; so much so that with the passage of time the comet became gradually faster, covering each day 50, 60, 70, 80, 90, and finally even 100 semidiameters of the Earth, namely in the vicinity of the Sun, as the calculation from the table above, p. 602, clearly shows. The apparent motion, however, was far different from this proportion: very slow, namely, at the beginning, very swift in the middle, and in turn very slow about the exit (as I mentioned a little before), indeed entirely stationary, as the adjoining small table shows.

[Margin: Quantâ velocitate, tum quâ apparentem, tum quà verum motum ſingulis diebusCometa inceſſerit.] *With what speed the comet advanced each day, in its apparent as well as in its true motion.*

Apparent and true motion in the orbit of the comet of 1472

Day, month	Apparent motion (deg. min.)	True motion (semidiameters of the Earth)	Day, month	Apparent motion (deg. min.)	True motion (semidiameters of the Earth)
January 13	0′	0 0	February 7	0° 26′	70 0
14	30′	33 0	8	0° 26′	72 0
15	40′	33 0	9	0° 25′	74 0
16	1° 10′	34 0	10	0° 25′	75 0
17	2° 20′	35 0	11	0° 25′	77 0
18	4° 25′	36 0	12	0° 24′	79 0
19	6° 0′	37 0	13	0° 24′	81 0
20	11° 0′	38 0	14	0° 24′	82 0
21	22° 31′	39 0	15	0° 24′	83 0
22	42° 4′	40 0	16		85 0
23	35° 36′	41 0	17		86 0
24	17° 0′	43 0	18		88 0
25	8° 0′	45 0	19		90 0
26	5° 0′	47 0	20		91 0
27	3° 0′	49 0	21		92 0
28	2° 30′	51 0	22		94 0
29	1° 40′	52 0	23		96 0
30	1° 18′	54 0	24		97 0
31	1° 5′	56 0	25		98 0
February 1	0° 58′	58 0	26		99 0
2	0° 52′	60 0	27		100 0
3	0° 42′	62 0			
4	0° 34′	64 0			
5	0° 29′	66 0			
6	0° 27′	68 0			

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It is therefore manifest that about the middle of its course the comet was endowed with an altogether wonderful speed, covering, that is, more than 40 degrees in one day; yet it is certain that, in like manner, just as its motion grew very swiftly at the beginning, so also afterwards it at once decreased, with due proportion kept and by no means irregularly (which I would have you note well). [Margin: Veritas noſtræ hypotheſeos iterum iterumq́; manifeſtè

[596] On the page the table stands in a ruled frame in the right part of the text block, beside the following paragraph, which is set in a narrow column to its left down to the words near the ecliptic. It is printed in two halves of three columns, divided by a narrow empty ruled column; the rows of the two halves stand level, and the right half ends with February 27, its remaining rows ruled and blank. The units are printed under the heads (Gr.M., degrees and minutes; Sem.T., semidiameters of the Earth). For January 13–15 the apparent motion prints one figure only, in the place of the minutes. Each true-motion cell prints two figures, the second 0 throughout; the page does not say what the second figure counts, and both are given as printed. The apparent motion is blank from February 16 to 27. Rules divide the rows into groups of three, except January 28–31 in the left half.

deducitur ex Cometæ phænomenis.] *The truth of our hypothesis is clearly deduced, again and again, from the phenomena of the comet.* This again corresponds very well with the words and the observations. But as this phenomenon is certainly most unusual, so there is doubtless no one who will not greatly marvel at it, especially one who does not yet sufficiently understand this theory, or is striving to understand it. Yet this astonishing appearance arose from nothing other than the fact that the phenomenon crossed quite close to the ecliptic, and that the Earth, at the same time, came as it were to meet it; and in that situation it could not have happened otherwise than that on January 21, with the Earth namely at P and the comet at R, as the lower drawing, in which the pro- portion of the lines for the four days from the 20th to the 23rd was taken somewhat larger to avoid confusion, of Figure W shows to the eye, the comet, by a certain law, was seen about the beginning of Libra or the end of Virgo. Conversely, on the 22nd, when the Earth had already passed the trace and had arrived at Q, on the other side of the great orb with respect to that trace, and the comet at T, the comet could be detected in no other place in the sky than about the beginning of Gemini. In this way, therefore, once 24 hours had elapsed, it was able to complete almost 40 degrees, namely in its own orbit, but in longitude 4 whole signs, always going straight on along the course it had taken, advancing in order; and our calculation demonstrates this once again.

[Margin: In primâ & ultimâ apparitione, penè ſtationarius viſus eſt.] *In its first and last appearance it seemed almost stationary.* But if that comet had come into view still earlier than January 13, its proper apparent motion along its path would have been extremely slow, because at the beginning the lines of sight drawn from the Earth through the comet were almost parallel, in the same way as those lines about its last appearance. In sum, in this way and in such a trajectory, all the phenomena, each and every one, can be saved very fittingly, as we have already said more than once, in agreement with Regiomontanus himself, who asserts that at the beginning and the end the comet moved slowly, but in the middle most swiftly, traversing in one day four whole signs, from the end of Virgo all the way to the beginning of Gemini, and likewise in one natural day a portion of a great circle of 40°: which was to be demonstrated.

[Margin: Regiomontan9 parallaxin præpoſterè deduxit.] *Regiomontanus derived the parallax back to front.* But you ask what, then, I infer about its parallax of 6 degrees, which Crüger mentioned. For my part, to confess it frankly, I can in no way be brought to believe that Regiomontanus himself investigated that parallax with full exactness from Spica, which was then near the comet, or from any other fixed star. Rather, led by a preconceived Aristotelian opinion, he conjectured that parallax roughly from the so immense extent of the path the comet covered in one day, perhaps by this reasoning. Since the Moon, in its daily motion, covers about 12 degrees each day at a distance of 33 semidiameters of the Earth according to Ptolemy (as Regiomontanus himself admits in the observation given by Crüger), he asked at what distance from the Earth this phenomenon stands, which by its proper motion completes 40° and more

in one day. By that reasoning he found the corresponding distance of the phenomenon from the Earth to be about 9 semidiameters of the Earth, or 8200 German miles; and only afterwards, in this way, that parallax of about 6 degrees, as the said author would have it, assuming the semidiameter of the Earth to be 913 German miles [Mill. Teuton.]: that is, he took the parallax from the distance, but back to front, since he ought first to have duly explored the parallax, and only then the distance itself. This view not only seems to me very probable, but stands firm with me until the observations themselves are first produced and the method shown by which he discovered the genuine parallax. Otherwise the tale of that parallax of 6 degrees is surely told to the deaf, however much one may read in the observation itself that this parallax was, as it were, dug out with suitable instruments arranged for the purpose.

[Margin: Parallaxis illa æſtimata, nec obſervationi, nec relationi Regiomontani reſpondet.] *That estimated parallax corresponds neither to the observation nor to the report of Regiomontanus.* And I am all the more induced to settle firmly on this very point, namely that Regiomontanus merely guessed the parallax by the reasoning already given, the less it corresponds either to the words or to the observation of the author. For he says: *Considering, therefore, the greatest parallax of the head of the comet from Spica, a star neigh- bouring it: which, when all irregularities had been reduced as far as possible, could not be taken as greater than 6 degrees, etc.* From this it is abundantly clear that this parallax of the comet was assigned by the author about the beginning of its appearance; and yet the comet, when it stood near Spica, was still slow, covering scarcely a few degrees by its daily motion, namely between January 13 and 20. But if he had conjectured that difference [of appearance] from its course as observed on the 21st and 22nd, it would not have been so out of keeping with reason.

[Margin: Ratione Regiomontani nullo modo parallaxes accuratè explorantur.] *By Regiomontanus's method parallaxes are in no way explored accurately.* But you may retort that Regiomontanus undoubtedly examined that parallax in his own way, by altitudes and azimuths, since he said: with suitable instruments arranged for this. But, as we have already impressed more than once, this way of determining parallaxes is very slippery, so that you can by no means draw anything certain from it in this matter: it is easy to go astray not only by several minutes but sometimes by degrees. And yet I very much doubt that that comet was ever duly and exactly observed by Regiomontanus by altitudes and azimuths, since he mostly used only the radius. But how much weight the radius deserves in that most delicate business, if observations must rest on this single instrument, is already known to students of mathematics from elsewhere, and has also been sufficiently exposed by us in its place. Not to mention that in Regiomontanus's time the whole host of the fixed stars had not yet been restored so accurately that altitudes and azimuths, or distances observed from the fixed stars, could be taken with the precision that was indeed due, and that the business of parallax, and above all that method of Regiomontanus, demands. [Margin: Keplerus jam olim deduxit, Cometam 1472 nunquam parallaxin 6 gr.

exhibuiſſe.] *Kepler showed long ago that the comet of 1472 never displayed a parallax of 6 degrees.* On these matters, certainly, much would remain to be said, had Kepler not already set it all out at sufficient length in the *Hyperaspistes*, Book III, Chapter XVII: namely that the comet by no means ever had so enormous a parallax, that is, one of 6 degrees, and that it stood much higher than 9 or 10 semidiameters of the Earth.

[Margin: Quænam phænomena in hoc Cometâ demonſtranda ſint ex hypotheſi.] *Which phenomena in this comet are to be demonstrated from a hypothesis.* But if this is not yet enough for anyone, let him, I ask, put forward another theory for saving all the phenomena, whether by any circular line whatever or by a straight one, it will be all the same, provided he demonstrates that the comet could both be near the Earth and nevertheless be slow about the beginning and the end and very swift in the middle, so much so that it could even exceed 40 degrees in one day along its path, and at the same time four signs of the zodiac in longitude; and moreover that it could proceed constantly under a great circle, and also rise and set together with the fixed stars: and then he will be a great Apollo to me, and I shall of my own accord hold out my hands to him. But in truth I am abundantly certain that this can never by any means happen. [Margin: Cometa anni 1472 nullâ aliâ ratione, quàm exhibitâ Trajectoriâ ſalvatur.] *The comet of the year 1472 is saved in no other way than by the trajectory shown.* For however much I strove with all my strength, and left nothing untried to see whether it could also be accomplished by some other route, I was nevertheless always writing letters in water, and it succeeded in no other way than by removing the comet's trajectory from the Earth farther than the Moon's orbit: namely, at its smaller distance from the Earth, to about 70 semidiameters of the Earth; but on January 13 to 500, and finally, on February 27, beyond 1000 semidiameters of the Earth. [Margin: Quanto intervallo à Terrâ fuerit remotus.] *At what distance from the Earth it was removed.* In this way, as has been demonstrated at length, all the phenomena are correctly established. But if you place the comet far lower, beneath the Moon, the phenomena are thrown into utter confusion, and you by no means reach the goal. Yet I grant of my own accord that in a higher position, and at a greater distance from the Earth than we have assigned to the comet, the matter can be carried out equally well, indeed almost more fittingly: so that that great- er elongation of the comet from the Earth does no harm, but rather shows the phenomena more clearly; and even if you suppose the trajectory at a nearer remove, at 100, indeed 150 semidiameters of the Earth, it nevertheless seems to perform such extremely unruly [?] leaps and motions there.

[Margin: Vt ut Autor ſummoperè allaboravit,Cometam propiùs ad Terram,infra ſc. 70 S.T. deducere; fruſtrà tamen deſudavit.] *However hard the author strove to bring the comet closer to the Earth, namely below 70 semidiameters of the Earth, he toiled in vain.* For the rest, I also left no stone unturned to bring the comet down as far as 9 or 10 semidiameters of the Earth, namely on the 21st,

when it was nearest to the Earth; but, as we have said, the undertaking succeeded in no way at all. But perhaps you imagine that [I] deliberately rejected and refused this very thing, namely that the comet hung in the air, as being entirely contrary to my opinion. Not at all, certainly. For I have never objected that some one of the comets could not at some time be thrust right up to the Earth, or carried across in its neighbourhood; rather, I have laid down that this can certainly happen, and indeed that [a comet] may sometimes graze the Earth itself in crossing; on this condition, however, that the cometary body could not remain about the Earth so long, but would at once fly off with very swift motion and leave the Earth behind. [Margin: Non obſtat ſententiæ Autoris, Cometas quandoq́; ipſam Atmoſphæram Telluris, aëremq́; vaporoſum tranare poſſe.] *It does not stand against the author's opinion that comets can sometimes pass through the very atmosphere of the Earth and the vaporous air.* For the trajectory lines, or the paths of the comets, are borne through the whole aether, and tend now to this part of the sky, now to that, so that it is not absurd that some comet could at a certain time pass not far from the Earth itself and furrow its atmosphere, as I have already granted more than once elsewhere. [Margin: Nulla datur generatio & corruptio Cometarum in aëre ſublunari.] *There is no generation and corruption of comets in the sublunary air.* This alone, however, we have denied, simply and consistently: that any comet is ever generated in our sublunary air and subsists continuously for its whole duration, still less that it can complete its course; rather, just as they sometimes fly in from the deepest aether and pass by the Earth, so, strictly following the straight path once taken, they make again for the most spacious heaven; and hence they successively take one position and distance from the Earth after another.

[Margin: Evidenti argumento oſtenditur, Cometam Regiomontani nec habuiſſe parallaxin 6 grad. nec in orbe noſtro T. vaporoſo extitiſſe.] *It is shown by a clear argument that the comet of Regiomontanus neither had a parallax of 6 degrees nor stood within our vaporous orb of the Earth.* Finally, if we in turn call to mind what was brought forward in Book III, and duly weigh what a rapid leap and what a most disordered motion some phenomenon would perform at a distance of 10 semidiameters of the Earth (namely, in what way, on any night, if it were granted to persist so long at such an elongation, it would seem by its motion to describe so irregular a circular line, and in what way it would appear now direct, now stationary, now retrograde), we can likewise without difficulty maintain again and again that it is certainly most absurd to attribute to this comet a parallax of 6 degrees and a distance from the Earth of 9 or 10 semidiameters of the Earth; since this comet of Regiomontanus by no means showed such enormous gaits and wondrous leapings, but indeed, at the time when it was nearest to the Earth, covering almost 40 degrees in one day by its proper motion, it followed the same course of its path continuously, advancing forwards, and in longitude with a constant retrograde motion. But enough and more of these things; therefore we do not think we should dwell on them any longer.

[Margin: De Cometâ 1531 Petri Apiani.] *On the comet of 1531 of Peter Apian.* Let us now pass to the other comet, that of 1531, observed by Apian; of which, however, the said author left us rather slight observations, so that he seems to have been more concerned with the extension of the tail than, indeed, with the place of the body. Nevertheless, lacking more certain ones, we have used its longitudes and latitudes for the present diagram, however much some of them seem to waver greatly. [Margin: Quo tempore apparuerit, & quali motu incesſerit.] *When it appeared, and with what motion it advanced.* Now this comet, as far as has been handed down by the authors, was seen from August 6 to September 3; at the beginning, indeed, for some time in the morning, before the Sun's rising; afterwards, however, in the evening, after sunset, it passed through ♋, ♌, ♍ and ♎, where it vanished. Its motion was fairly swift, for each day it advanced about 4° or 5° in its orbit; in latitude it was always northern, and direct, as is abundantly clear from our ephemeris, Section X of Book I. [Margin: Calculi data.] *The data of the calculation.* Having therefore duly considered everything that occurs in this diagram, we chose for the calculation the longitudes of the comet on August 13, 17 and 23, and the latitudes on the 13th and 23rd of the same month. Accordingly, the trajectory cuts the annual orbit in ♓ 26° 30′ at X, and runs under the ecliptic toward ♍ 28° 40′; the angle of the trajectory with its trace, or base, comes to 3° 24′. Next, the trajectory proceeds through the lines of sight [viſorias] above their intersections. In this way the whole trajection falls within the annual orbit, and all the phenomena are preserved as desired, and demonstrated.

[Margin: Ex Schemat[[e/o]] phænomena hujus Cometæ deducuntur.] *The phenomena of this comet are derived from the diagram [?].* First: up to August 13, at H, the comet was continually found to be a morning [star]; but on the 15th of the same month it held a conjunction with the Sun; and because its latitude at that time was only about 20° north, it then withdrew from sight, until on the 17th it became an evening [star] at K, and it remained in that appearance until its disappearance. Second: in this way the phenomena now also hold in the assigned diagram. Not only was [the comet] continually direct in longitude, but its proper motion on all the days, according to the observations, was also nearly equal. Moreover, the longitudes and latitudes derived from this theory of ours likewise correspond very well to the observed ones, as the calculation shown in this small table attests; except that the computed ones came out somewhat smaller about the beginning.

Aug.	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)
	In the year 1531										
13	19° 15′ ♌	23° 15′ B.	19° 15′ ♌	23° 15′ B.	29° 30′ ♋	6° 15′	1798	2354	772	0	1956
15	29° 24′	22° 25′	29° 30′	22° 21′	1° 26′ ♍	7° 56′	1853	2524	762	170	2003
17	9° 14′ ♍	21° 0′	9° 14′ ♍	20° 54′	3° 22′	5° 52′	1967	2709	751	185	2106
19	18° 20′ ♍	50′ B.	18° 11′ ♍	18° 59′	5° 18′ ♍	12° 53′	2145	2919	738	210	2268
21	26° 10′	17° 12′	26° 4′	16° 50′	7° 14′	18° 50′	2394	3163	724	245	2501
23	2° 51′ ♎	14° 31′	2° 51′ ♎	14° 40′	9° 10′	23° 41′	2702	3449	707	287	2795

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Hence one can see, by clear reasoning, that the trajectory was not altogether straight but partly curved, and indeed with a greater and more notable curvature about the middle of the trajectory, as has been sketched in the diagram and will be shown below as well, more fully and more plainly. [Margin: TrajectoriaCometica noſtra non omninò eſt recta, ſed parte incurvata.] *Our cometary trajectory is not altogether straight, but curved in part.* But what the genuine reason for this is — why every trajection in comets is not exactly straight but partly bent, and also how, from where, and when it inclines and curves — will be told only when all the diagrams have been produced and explained. Third: from the attached small table we likewise find clearly, according to the figures of the calculation, that this comet in the year 1531 moved in the highest aether:

[597] The table has no title; it stands across the full measure between the paragraph above and the one below. It is ruled in twelve columns; the first carries the days of August, its head the abbreviation Aug. printed in the row of the year, and the units are printed in a row of their own under the heads (Gr. M. or Gr. Mi., degrees and minutes; Sem.T., semidiameters of the Earth), given here in brackets after each head. The row of the year, printed ANNO M. D. XXXI., spans the eleven columns to the right of the days. Signs of the zodiac stand as printed, only where the page prints one; B. (borealis, north) stands as printed after the latitudes of the 13th and 19th. A rule across all columns divides the rows of the 17th and 19th; a short rule in the elongation column, between the rows of the 15th and 17th, is not reproduced.

[Margin: Quot Semidiametris Terræ Cometa à Terrâ remotus fuerit.] *By how many semidiameters of the Earth the comet was removed from the Earth.* namely, that about its beginnings it stood about 2000 semidiameters of the Earth from us, and about its exit about 3000 semidiameters of the Earth. Even if we had decided to set it much lower in the drawing, we could nevertheless by no means bring it about that the delineation and the calculation, with regard to the ob- servation, satisfied it in all respects. Fourth: as regards the proper true motion along the trajectory line (however nearly equal the apparent [motion] was observed to be over the whole duration), it was altogether unequal. For at the beginning it covered only 84 semidiameters of the Earth, but about the end, on August 23, it flew through more than 150 semidiameters of the Earth, so that at the last it was almost twice as fast, while a fixed increment of acceleration was nevertheless always kept. [Margin: Motus proprius verus in Trajectoriâ ab initio fuit tardior, in fine verò multò velocior.] *The proper true motion in the trajectory was slower at the beginning, but much swifter at the end.* By this speed it certainly far surpassed the earlier comet of 1472. Concerning these matters there are several questions, pleasant and no less most useful, which (be it said without boasting) have up to now been touched on by no one even lightly, still less fully uncovered; we reserve them for their proper place, to be discussed at greater length. You see, therefore, kind reader, that this comet of the year 1531 too is entirely subject to the laws of the trajectory.

[Margin: De Cometâ 1532 P. Apiani.] *On the comet of 1532 of Peter Apian.* With equal success the matter also turns out in the other comet of Apian, observed in the year 1532. On that author's observations we both constructed the attached diagram and undertook the calculation. Above all, the longitudes of October 3 and 19, and also of November 8, served us as a foundation, together with the latitudes of October 3 and November 8. The trace of the trajectory cuts the annual orbit in ♈ 21° 50′, and runs under the ecliptic toward ♍ 15° 0′; the angle of the trajectory with the trace is 36° 18′. What the calculation shows, however, is evident from this small table: [Margin: Quid differentiæ intercedat, inter Cometas 1531 & 1532.] *What difference there is between the comets of 1531 and 1532.* namely, that the proper true motion in its trajectory decreased little by little from day to day, but was much slower than the motion of the preceding comet; while the apparent [motion] was of almost the same speed, as far as could be drawn from the observations. Our diagram also shows the same, since the comet kept almost the same distance from the Earth for the whole time of its course. With respect to the ecliptic it was continually direct, just like the comet of Regiomontanus. On the other hand, the trajectory of this comet is carried below the intersections of the lines of sight [Sectiones viſorias]. Moreover, about the beginnings of its appearance it was removed from the Earth by a still somewhat greater interval than that other one of 1531, but about the exit the contrary is found; the reason is evident from the diagram. For in the former the trace stood far nearer the Earth at the beginning than in the course of time, and the chief reason for this is that the proper motions of the

comet and of the Earth went, as it were, in opposite directions. In the latter, however, the trace of the comet stays away from the Earth at almost the same distance; and although the trace seems to move away from the great orb and to ascend the trajectory, nevertheless, since the Earth was carried in the same direction, and indeed with a swifter motion, [the trace] for that reason always kept the same distance from the Earth, right to the end.

Oct. & Nov.	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)
	In the year 1532										
October 3	11° 25′ ♍	0° 12′ A.	11° 30′ ♍	0° 20′ A.	19° 50′ ♎	820	2390	2280	436	0	2430
14	0° 0′ ♎	0° 0′	29° 25′	0° 7′ B.	0° 46′ ♏	21′	2423	2880	5	744	2423
19	5° 46′	4° 51′ B.	6° 40′ ♎	4° 31′	5° 45′	29° 5′	2444	3136	193	318	2452
31	21° 30′ ♎	15′	22° 36′	14° 0′	17° 45′	25° 9′	2447	3704	610	705	2601
November 8	3° 35′ ♍	0° 36′	3° 10′ ♏	0° 30′	25° 49′	22° 39′	2386	4024	845	397	2548

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Diagram. A full-page engraved plate, with no text on the page, carrying two figures, one above the other. The upper figure is titled *Theoria Cometæ*

[598] The table has no title; it stands across the full measure below the paragraph above, and its heads and unit row are those of the table of 1531 on the preceding page. The first column prints the months, Oct. & Nov., beside the row of the year, printed ANNO M. D. XXXII., which spans the other eleven columns; it then prints Oct. before the first day, and Nov. on a line of its own above the last day. Signs of the zodiac stand as printed, only where the page prints one; A. (australis, south) and B. (borealis, north) stand as printed after the latitudes. The elongation for October 3 is printed 3, a space, then 820, the 8 set against the 20; it is given here as printed. A rule across all columns divides the rows of October 19 and 31.

Anno 1531 ab Appiano obſervati., Theory of the comet observed by Apian in the year 1531. Near its top stands S, with dotted lines running down from it; a fan of lines runs down from the upper left to cross near the middle, each labelled with a longitude; a long line runs down to the right from the upper left to X, carrying the points M, L, K, I, H; and a large arc runs from the left down through the lettered points A to F, dated in August, and up to the right through X. To the right below X, two nearly horizontal lines are joined by six dotted uprights, with letters below the lower line. The lower figure is titled *Theoria Cometæ Anno 1532 ab Appiano obſervati.*, Theory of the comet observed by Apian in the year 1532. Below the foot of the upper arc stands S, with dotted lines running down from it; a fan of lines runs down to the left from the upper right, each labelled with a longitude; the points H to N lie on a line crossing the fan; an arc runs from the left down through lettered points, with dates beside the dotted lines above them, and up to the right; a long line labelled as the trace rises from the lower left to X on the arc. At the foot stands a small figure of a horizontal line crossed by a rising line, with dotted uprights between them. The labels engraved on the plate:

- *Theoria Cometæ Anno 1531 / ab Appiano obſervati.* (title of the upper figure, upper right): Theory of the comet observed by Apian in the year 1531.
- Upper figure, near the top: S, with 29° 30′. ☌ to its left.
- Upper figure, along the fan of lines from the upper left, from left to right: 2° 51′. ♎; 26° 4′. ♍; 18° 11′. ♍; ♍ 9° 14′; 29° 30′. ☌ (just right of S); 19° 15′. ☌.
- Upper figure, along the long line from the upper left to X: *Trajectoriæ*, Of the trajectory (near its upper end); the points M, L, K, I, H; *Vestigium.*, Trace (toward X).
- Upper figure, on the arc from left to right: ♒; ♓; A, B, C, D, E, F, with the dates below them 13. 15. 17. 19. 21. 23. *Augusti.*, August 13, 15, 17, 19, 21, 23; X, with ♈ above it; ♉ (at the upper right end of the arc).
- Below the lower of the two lines joined by dotted uprights, to the right below X, from left to right: N, M, L, K, I, H.
- *Theoria Cometæ Anno 1532 / ab Appiano obſervati.* (title of the lower figure, left): Theory of the comet observed by Apian in the year 1532.
- Lower figure, near the top: S, with 19° 50′. ♎ to its left.
- Lower figure, along the fan of lines from the upper right, from left to right: 3° 10′. ♏; 22° 36′. ♎; 6° 40′. ♍; 29° 25′. ♍; 19° 0′. ♍; 11° 30′. ♍.
- Lower figure, along a line rising to the right: *Trajectoriæ.*, Of the trajectory.
- Lower figure, the points on the line crossing the fan, from left to right: H, I, K, L, M, N, with O [?] beyond them.
- Lower figure, on the arc from left to right: ♈; A; X; I; C; ♉; D; E; F; G; ♊.

- Lower figure, the dates beside the dotted lines above the arc, from left to right: *3. Octobr.*, October 3; 9.; 14.; 19.; 25.; 13.; *8 Novembr.*, November 8.
- Lower figure, along the long line rising from the lower left to X: *Vestigium*, Trace.
- Foot of the plate: H, I, K above a horizontal line; L, M, N, O below it.
- *Fig. X.* (lower left): Fig. X.
- *Autor ſculpsit.* (lower right): Engraved by the author.

Moreover, the derived longitudes and latitudes agree fairly precisely with the observed ones. In some, indeed, a very small discrepancy presents itself; but it is to be imputed only to the coarser observations, as having been obtained with ruder instruments. For from such [observations], as the learned know very well, everything cannot agree so accurately among itself. [Margin: Commonſtratur, Schema & calculum cum obſervatione Cometæ 1532 optime convenire.] *It is shown that the diagram and the calculation agree very well with the observation of the comet of 1532.* The latitudes, however, correspond better, and they reveal a similar phenomenon in this [comet] as in that one: [Margin: Etiam hujus Cometæ Trajectoria ex parte fuit inflexa.] *The trajectory of this comet too was in part bent.* namely, that the trajectory and its trace did not proceed altogether straight (as we supposed in the diagram), but bent themselves somewhat, though in a dissimilar way with respect to the earlier one. For in that comet the curvature was greater about the first appearance than about the last; in this one, however, we noticed the contrary. But from where these things come about, as I was saying just now, will have to be investigated a little later.

Nothing more can be derived concerning this hairy star, for lack of observations. About it Milichius noted only this: that at the end of September (in the year 1532) the comet began to be seen, with a certain dim pallor, in the eastern region of the sky before sunrise; and that it lasted three whole months, and surpassed the earlier one both in duration and in size. Fracastoro adds that its head was three times larger than Jupiter, and that it had a long coma.

Finally, as regards the tail, from this hypothesis of ours the reasons are also ready to hand why in this comet it was found to be very long, [Margin: Tum caudæ, tum phænomena reliqua hujusCometæ convenienter hâc noſtrâ Trajectoriâ comprobantur.] *Both [the phenomena] of the tail and the other phenomena of this comet are fittingly confirmed by this trajectory of ours.* and indeed much longer than [that] of the comet of 1531, even if you suppose that the true length of both was altogether the same; although there is no necessity that tails should always be equal in themselves, but they vary in diverse ways, by reason of the matter adhering to the head, or of the cometary atmosphere. The comet of 1531 was at first nearer to conjunction with the Sun, where tails, even if they have some latitude, mostly appear very short. About its last appearance it was indeed removed from the Sun by an equal interval with the comet of 1532; but there was this difference, that the former, about its exit, stood much further from the Earth than this one of 1532. For that reason the tail of the latter was seen to be very long, especially on the last days, in its position nearer to the

Earth, as is clearly evident from the diagram. All of which is once again proof that the individual phenomena of this comet, too, can rightly be saved by a fitting trajectory.

[Margin: Cometa anno 1577 à Tychone debitè obſervatus eſt.] *The comet in the year 1577 was duly observed by Tycho.* There follows the comet of the year 1577, observed most exactly on every single day, with suitable instruments, by that noble investigator of the heavens and the stars, Tycho Brahe. Concerning it there is no doubt — since it was observed accurately beyond all the other preceding ones — that we shall obtain something certain from it as well. But first of all let us see whether trajectory motion results from this comet too. [Margin: Tycho omni opere adnixus eſt, quò Cometam hunc per circulos evinceret; ſed fruſtrà.] *Tycho strove with every effort to prove this comet [to move] by circles; but in vain.* Tycho indeed left no stone unturned to defend the motion of this comet by a circle (whose centre would be the Sun, as in all the other planets), yet larger than the eccentrics of Mercury and Venus, so that it might digress from the Sun further than these as well, namely as far as a sextant [a sixth part] of the sky: as can be seen from his diagram, and from what he set out at length in the same place, *Progymnasmata*, Book II, Chapter VIII. Yet he candidly admits, on p. 192, that in this very circular course about the Sun the comet did not always show an equal pace; in that at the beginning, in the perigee of its circle, it proceeds thus far more slowly than afterwards; contrary to the matter's evi- dent reason, and to the observations themselves, which are beyond doubt. He therefore saw very well, without doubt, that this would be quite absurd, since the apparent daily motion, which he himself presents in Book II, Chapter V, very clearly reveals that inconvenience: namely, that [the comet] was swifter about its beginnings than in its more advanced age. For at the beginning of December that motion was observed to be only 1°; afterwards, about the beginning of January, only 30′; and at the last scarcely 16′. [Margin: Quanquam Tycho incunvenientiam ſuæ hypotheſeos benè vidit, tamen in ſententiâ perſtitit.] *Although Tycho saw well the inconvenience of his hypothesis, he nevertheless persisted in his opinion.* Yet, paying no attention to these things, he persisted in his opinion, as if [the comet] had always completed equal motions in its orbit, because he could extricate himself from these diversities and absurdities by no other way. Nevertheless he frankly admits that it would be more in keeping with reason if the theory corresponded better to the observation. For he says in the same chapter cited, pp. 193 and 194:

I confess indeed that it would be more fitting if the comet, in this very orbit, had completed equal arcs in equal intervals of time over its whole duration. For in this way the simple uniformity of the revolution would be preserved more correctly, namely with the same regularity by which the planets themselves constantly keep a perpetual equality in their circuits. [Margin: Judicium Tychonis de ſuâ Theoriâ orbiculari.] *Tycho's judgement on his circular theory. And although this very inequality which befalls the comet in its own circumgyration might be limited and corrected — either by the centre of its orbit, twisted circularly about the Sun in the opposite direction and in*

the requisite manner, or by an orbicular addition on the circumference of that orbit, by whose help the motion would now be checked and now relaxed — yet because by such an entanglement of motion this business would acquire more obscurity and concealment than light and readiness, I was unwilling to heap up a more intricate composition of various motions in order to preserve the equality; especially since it is not at all fitting that the bodies of comets, which vanish so quickly, should be subject to such artfully composed and manifoldly involved windings of motions. I therefore preferred to keep the daily steps of the same comet in its orbit about the Sun such as experience itself supplied them to us, notwithstanding that they were a little slower from the beginning, but afterwards became swifter in a successive course.

You see, therefore, that although he laboured with great care and anxiety to preserve the comet's course by a circular motion, he nevertheless ploughed the shore. [Margin: Vt per circulos Cometarum phænomena nullo pacto, ſic per lineam Trajectoriam omnium optimè ſalvantur.] *As the phenomena of comets are by no means saved by circles, so they are saved best of all by the trajectory line.* I say nothing of the fact that the matter would have sunk into still greater absurdity if he had had to deduce the path of all the other comets from the hypothesis, and to demonstrate all their phenomena: what disordered circles, I ask, would it have been necessary to invent! Most comets would not only reject the Sun as their centre, but would also claim for themselves wonderful and most absurd eccentricities — and nevertheless, as I think, with unhappy success. Our trajectory motion, however, is repugnant to none of all the comets duly observed up to now. Indeed, I am entirely confident too that you will happily and aptly demonstrate all the others which may perhaps come in the future, by this straight line of course of ours, in whatever part of the sky as well, provided their course is explored exactly, however untimely they may seem. [Margin: Etiam ii,qui videntur quà motum immoderatiſſimi, atq; uno die totum Signiferum peragrare, minimè curſum rectum reſpuunt.] *Even those which seem most immoderate as regards their motion, and to traverse the whole zodiac in one day, by no means reject a straight course.* For that reason, toward the end of this Book, I shall set out comets that are wonderful and admirable as regards their motion, all of them to be saved plainly by this theory of ours. Among them some will be found for which it is not contrary to traverse five whole signs of the zodiac in one day, and indeed with this repeated a second time; indeed, even others able to run through the whole zodiac after two or three months have elapsed, at the same time with a regular motion, proceeding under some great circle, and remaining perpetually in the highest aether.

Diagram. A full-page engraved plate, with no text on the page, carrying a single figure titled *Theoria Cometæ Anno 1577 à Tychone obſervati.*, Theory of the comet observed by Tycho in the year 1577. A fan of lines runs down from the top of the figure toward the lower right, converging near the middle at P; each line is labelled near its upper end with a longitude. A long line runs down to the right from the upper left, carrying the points O, N, M, L, K, I, H, and is labelled as the trajectory beyond H and as of the comet at its lower

right end. S stands at the upper right of the figure, with a longitude beside it; a dotted line runs from S to M, and dotted lines run from S down to the points of a large arc. The arc, labelled the great orb, runs from the upper left down to A and round to the right through the lettered points B to G, with dates beside the dotted lines above them, from November 13 to January 12, and a sign at its right end. At the foot stands a small figure of a horizontal line with dotted uprights above it, crossed at its right end by a long line, with letters below it. The labels engraved on the plate:

- *Theoria Cometæ Anno 1577 à / Tychone obſervati.* (title, near the top, right of centre): Theory of the comet observed by Tycho in the year 1577.
- Along the upper ends of the fan of lines, from left to right: 12 50. ♓ (no degree or minute sign printed); 9° 48′. ♓; 6° 27′. ♓; 2° 38′. ♓; 28° 15′. ♒; 22° 59′. ♒; 16° 20′. ♒; 7° 33′. ♒; 25° 10′. ♍; 7° 10′. ♍.
- Along the long line from the upper left: the points O, N, M, L, K, I, H; *Trajectoria.*, Trajectory (beyond H); *Cometæ.*, Of the comet (at its lower right end).
- Upper right of the figure: S, with 1° 54′. ♐ to its right.
- Below the long line, beneath N and M: a looped letter or sign [?]; to the right below it, near the upper end of the arc: a looped letter or sign [?].
- Along the arc from the upper left: *Orbis Magnus.*, The great orb.
- At the crossing of the fan of lines: P.
- Left of the line ending at A: H.
- The points of the arc from left to right: A, B, C, D, E, F, G, with ♌ at the right end of the arc, and a sign [?] on the arc between the dates 7 and 13.
- The dates beside the dotted lines above the arc, from left to right: *13. Novemb.*, November 13; 19.; 25.; *1 Decemb.*, December 1; 7.; 13.; 19.; 25.; 31.; *6 Januarii.*, January 6; 12.
- Foot of the plate, below the horizontal line, from left to right: O, N, M, L, K, I, H.
- *Fig. Y* (lower left): Fig. Y.
- *Autor ſculpsit.* (lower right): Engraved by the author.

[Margin: Quo tempor[[é/è]] Cometa anno 1577 primùm illuxerit.] *When the comet in the year 1577 first shone forth.* But let us return to the comet of the year 1577, which was first detected by Tycho on November 13 and lasted until January 26 of the following year. What path it took — namely through Sagittarius, beside the hand of Antinous, the tail of Delphinus, through the nostrils of Equuleus, straight toward Scheat of Pegasus, leaving its head somewhat to the south, and that it finally disappeared in the space midway between Scheat and the two very small stars in the breast of Pegasus — is found at greater length in Tycho, *Progymnasmata*, Book II. [Margin: Quo motu fuerit præditus.] *With what motion it was endowed.* Among other things, however, it is especially worth noting that this comet advanced in the order of the signs, in northern latitude; and that upon its orbit, about the beginning, it covered six or five degrees with a swifter motion, and again about the end, with a rather slower one, scarcely half

a degree, indeed scarcely a few minutes: as Tycho's ephemeris of the apparent motion (*Progymnasmata*, Book II, Chapter V, p. 86), and at the same time the longitudes and latitudes of the comet for all the days, which we have used for the calculation, plainly show.

In accordance with these observations, therefore, we made our delineation and undertook the calculation; and the results, following the analysis given above on the occasion of the comet of 1652, we have entered in the small table that follows. [Margin: Quibus datis calculus & Schema innitantur.] *On what data the calculation and the diagram rest.* For the calculation, however, we used, in preference to the others, the longitude of November 13 and also of December 1, 13 and 31, and the latitude of the day November 13 and of December 13; and in such a way that the trajectory cuts the annual orbit of the Earth in ♈ 24°, and tends toward ♏ 26° 15′ in the ecliptic; and next, that the angle of the trajectory itself with its base, or trace, on the plane of the ecliptic is 51° 53′. With these things so established, the trace proceeds between the Sun and the Earth, and crosses the lines of sight [viſorias] above their intersections; so that the trajectory intersects the trace, or the plane of the ecliptic, on the right at H, at a certain angle. From then on the comet is seen to move away steadily more and more, both from the Earth and from the Sun, and all the motions are preserved very elegantly.

1. Namely, according to the given hypothesis, the comet always turns out direct, and its proper motion is also far swifter at the beginning than at the last. [Margin: Vnde Cometa ſemper direct[9], & motu concitatiori ab cxordio [recte: exordio] latus fuerit.] *From what cause the comet was always direct, and was carried with a swifter motion from the beginning.* The reason for these appearances is plain from the attached diagram: namely, that the trace, or trajectory, crossed the lines of sight so obliquely, and indeed successively still more obliquely. Besides this, the Earth at A, proceeding toward G, gradually moved further away; but above all, that daily motion was seen to be still slower for this reason, that the Earth, with respect to the comet, was carried forward in altogether opposite directions. And hence the daily angles of vision gradually decreased from day to day and became smaller. For the angle B P A, or its vertical angle H P I, is certainly greater — that is, on November 13 — than G Q R, or its vertical angle, and so on. Indeed, if the comet had been able to last 24 or 25 days longer, until the Earth had reached the intersection of the trace and the annual orbit at the opposite point X, and had passed the comet's trace, it would have been found plainly stationary as to appearance; yet shortly afterwards direct again, both as regards longitude and as regards its line of travel. [Margin: Vltimò, penè ſtationarius factus eſt.] *At the last it became almost stationary.* This is likewise confirmed by Cornelius Gemma, in a certain little work published on the same comet, p. 33: he observed it almost stationary in the month of January in the year 1578.

[Margin: Quando & quomodo ſtationem Cometæ ineant.] *When and how comets enter upon a station.* But what the cause of this phenomenon is can indeed be stated very easily: namely, when the Earth has passed beyond the trace and has reached the other segment of the annual orbit; and also that the comet then appears to proceed no longer above the sections, but below them. Yet this very reason is not yet understood so readily by just anyone, unless certain theorems on motion and trajection are first set out and demonstrated; for that reason this matter must be deferred to that place.

[Margin: Theoria noſtra cum obſervationib[9] & phænomenis hujus Cometæ 1577 optimè convenit.] *Our theory agrees very well with the observations and phenomena of this comet of 1577.* From what has been said, therefore, it is plain that all the appearances agree very well with this theory of ours; and that it can be defended no less properly why the head and tail of this comet appeared far larger at the beginning, when it stood at H and the Earth at A, as at a nearer distance, than about its exit at N and O, in those more remote places, the Earth being placed, namely, at F and G. [Margin: Quanto intervallo à Terrâ elongatus fuerit.] *By how great an interval it was removed from the Earth.* For the interval of the comet from the Earth, taken from the attached table according to our hypothesis, with the distance of the Sun from the Earth given as 5157 semidiameters of the Earth, clearly establishes that at the beginning it was only 2365 semidiameters of the Earth, but at the end 10,300 semidiameters of the Earth; that the comet was removed from us almost twice as far as the Sun itself, in the middle of its appearance; but that in the course of December the Sun and the comet were equally far away. This agrees fittingly with Tycho's parallax, which he found in the month of December to be 3′; that is, according to his hypothesis, [the comet] stood at as great an interval from the Earth as the Sun itself, while about its disappearance it was carried at a much greater remove.

[Margin: Tycho minimè à ſcopo aberravit in determinandâ parallaxi hujus Cometæ.] *Tycho by no means strayed from the mark in determining the parallax of this comet.* Very many indeed — especially Claramontius, that most bitter enemy of Tycho — have judged that Brahe strayed very far from the path in determining the parallax of this comet. But so far is he from having assigned too small a parallax that he rather set it too large, and erred on the side of excess. For from our theory (from which it can always be more or less discerned, even without any calculation, whether any phenomenon proceeds near at hand or far off) the parallax came out at the beginning as no more than 2′, and at the last as only 20″, the parallax of the Sun being taken, namely, as 40″: and this is certainly far smaller than Tycho's, for he grants it 19′ at the beginning and 2′ at the end.

Nov., Dec., Jan.	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)
	In the year 1577										
13	7° 15′ ♍	8° 59′ B.	7° 10′ ♍	8° 50′ B.	1° 54′ ♐	35° 16′	2337	1995	359	0	2365
19	24° 35′	17° 15′	25° 10′	17° 42′	7° 54′	47° 16′	2847	1563	909	700	2988
25	7° 24′ ♒	22° 5′	7° 33′ ♒	22° 21′	13° 54′	53° 39′	3507	1144	1443	679	3792
1	16° 21′ ♒	24° 47′ B.	16° 20′ ♒	25° 1′ B.	19° 54′ ♑	56° 26′	4207	736	1964	661	4643
7	23° 10′	26° 12′	22° 59′	26° 14′	25° 55′	57° 4′	5020	335	2474	649	5597
13	28° 9′	27° 18′	28° 15′	27° 5′	1° 56′ ♍	56° 19′	5817	61	2979	641	6533
19	2° 45′ ♓	28° 1′ B.	2° 38′ ♓	27° 46′ B.	7° 58′ ♍	54° 40′	6613	452	3481	633	7473
25	6° 36′	28° 29′	6° 27′	28° 10′	14° 0′	52° 27′	7415	839	3971	627	8411
31	9° 48′	28° 47′	9° 48′	28° 34′	20° 1′	49° 47′	8196	1223	4461	622	9332
Jan. 6	12° 51′	29° 1′	12° 50′	28° 42′	26° 2′	46° 48′	9033	1604	4946	618	10300

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[Margin: Cometa 1577 omnes quidem circulos, sed non convenientem Trajectoriam abhorret.] *The comet of 1577 abhors all circles indeed, but not a fitting trajectory.* As for the motion along the line of its course, which Tycho could

599 The table has no title; it stands across the full measure below the paragraph above. It is ruled in twelve columns; the first carries the days, its head the abbreviations Nov., Dec. and Jan. printed in three lines beside the row of the year, and the units are printed in a row of their own under the heads (Gr. M. or Gr. Mi., degrees and minutes; Sem.T., semidiameters of the Earth), given here in brackets after each head. The row of the year, printed ANNO M. D. LXXVII., spans the eleven columns to the right of the days. In the first column the month names are set sideways beside the days: Novem. beside 13, 19 and 25; Decem. beside 1, 7 and 13; Decem. again beside 19, 25 and 31; the last row prints Jan. 6. Signs of the zodiac stand as printed, only where the page prints one; B. (borealis, north) stands as printed after the latitudes of November 13, December 1 and December 19. Rules across all columns divide the rows of November 25 and December 1, and of December 13 and 19; a short rule with turned ends in the column of the distance of the same perpendicular, between the rows of December 7 and 13, is not reproduced.

not bind to fixed laws by means of a circular path, since it so utterly rejected all regularity of motion: according to our hypothesis it likewise diminishes daily, fittingly and proportionally, like that of the comet in the year 1532. In reality, however, it was in itself much swifter than this comet of 1532. What the cause of this difference is will be plain from what follows. Moreover, the deduced longitudes also agree very closely with the observed ones: some, indeed, depart from them by scarcely one or two minutes; and this is to be put down either to some of the observations, or to the fact that in Tycho's ephemeris they were perhaps not extended so precisely to every single day. The latitudes deduced from the hypothesis, however, as is evident, all exceed the observed ones, with a single exception, from the beginning to the middle of its course; but about the departure of the comet these in turn are greater than those. [Margin: Et hujus Cometæ Trajectio non omninò recta extitit, ſed Solem versùs ex parte obliquabatur.] *The trajectory of this comet too was not altogether straight, but was partly bent toward the Sun.* From this it is established once again that the trajectory of this comet too does not extend entirely in a straight line, but is curved to some extent — and indeed with a greater bending at its rising than at its setting — namely toward the Sun; from a certain singular appetency, to be explained in its own place. But we have dealt enough, for our purpose, with this comet of 1577 as well.

Now let us go on to where the sequence has brought us, namely to the comet of 1585, observed with strenuous effort from October 10 to November 12 both by Tycho and by Rothmann. [Margin: Cometa anno 1585 à Tychone, & Rothmanno ſedulò obſervatus eſt.] *The comet of the year 1585 was carefully observed by Tycho and by Rothmann.* It showed at first a southern latitude, and then a northern one, advancing successively with a direct motion in the order of the signs. Its proper motion, however, became slower from day to day: at its entry it was 2° 18′, but at its exit only 30′, according to the observations of Tycho as well as of Rothmann. For our purpose, however, we have used almost all [the observations] of the latter author (since Rothmann discovered the comet earlier than Tycho), except two observations made by Tycho on November 7 and 11, at which time it did not fall to Rothmann to notice the comet. Meanwhile, however, all the observations of both authors agree with one another almost exactly, which shows the skill of the observers, so that there is all the less reason to doubt the observed values; except that Rothmann derived the latitude of October 10 somewhat larger, and the longitude of November 3 smaller by a few minutes; and for that reason these had first to be corrected. [Margin: Quâ ratione calculus poſit⁹, ſchemaq́; conſtructum ſit.] *On what basis the calculation was set out and the diagram constructed.* For constructing the diagram and undertaking the calculation, we used the longitude of October 10 and 22, and also of November 3 and 11; and the latitude of October 10 and of November 11. This was done in such a way that the base, or trace of the trajectory, nowhere cuts the annual orbit; yet if a straight line parallel to it is drawn from some position of the Earth, that line will tend in the ecliptic

toward ♋ 12° 13′. The angle of the trajectory itself with the trace is 9° 41′. The length of the perpendicular from the comet onto the plane of the ecliptic on October 10 has thus been taken as 1570 semidiameters of the Earth, as the table that follows shows.

Oct., Nov.	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)
	In the year 1585										
10	29° 13′ ♓	4° 44′ A.	29° 13′ ♓	11° 40′ A.	28° 15′ ♌	30° 58′	1570	0	324	0	1603
14	10° 7′ ♈	7° 26′	10° 3′ ♈	7° 29′	2° 15′ ♍	157° 48′	1642	633	216	642	1657
18	19° 38′	3° 25′	19° 38′	3° 29′	6° 14′	163° 24′	1791	1259	109	635	1794
22	27° 29′ ♈	3′ A.	27° 29′ ♉	5° A.	10° 14′ ♎	167° 15′	2004	1880	3	630	2004
26	3° 40′ ♉	1° 34′ B.	3° 43′ ♉	2° 36′	14° 14′	169° 29′	2272	2499	103	628	2275
30	8° 36′	4° 33′	8° 44′	4° 36′	18° 13′	170° 31′	2588	3117	208	627	2614
3	12° 35′ ♉	6° 3′ B.	12° 40′ ♉	6° 4′ B.	22° 13′ ♎	170° 27′	2940	3734	313	626	2957
7	15° 43′	7° 10′	15° 44′	7° 10′	26° 12′	169° 32′	3332	4351	419	626	3358
11	18° 15′	7° 57′	18° 15′	7° 57′	0° 12′ ♐	168° 3′	3751	4967	524	625	3788

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[600] The table has no title; it stands at the head of the page across the full measure, above the paragraph that follows. It is ruled in twelve columns, in the same arrangement as the table of the comet of 1577 two pages earlier; the first carries the days, its head the abbreviations Oct. and Nov., joined by an ampersand and printed in three lines beside the row of the year, and the units are printed in a row of their own under the heads (Gr. M., degrees and minutes; Sem.T., semidiameters of the Earth), given here in brackets after each head. The row of the year, printed ANNO M. D. LXXXV., spans the eleven columns to the right of the days. In the first column the month names are set sideways beside the days: Octobr. beside 10, 14 and 18; nothing beside 22, 26 and 30; Novem. beside 3, 7 and 11. Signs of the zodiac stand as printed, only where the page prints one; A. (australis, south) stands as printed after the latitudes of October 10 and 22, and B. (borealis, north) after those of October 26 and November 3, only where the page prints them. Rules across all columns divide the rows of October 18 and 22, and of October 30 and November 3.

[Margin: Nihil abſurdi noſtraTheoria, etiam in hoc Cometâ producit.] *Our theory produces nothing absurd in this comet either.* In this way, then, each and every phenomenon occurring about this adventitious star is cleared, readily and conveniently, of all absurdity and incongruity. Its apparent proper motion decreased steadily from day to day, and so likewise did its true motion in the trajectory, continuously and gradually; nevertheless it was not a little swifter than [that] of the preceding comet of 1577, whose true motion along its path, even when it was at its swiftest, was found to be only 118 semidiameters of the Earth; but the comet of 1585 quickened its pace to 161 semidiameters of the Earth. Besides this, the longitudes from the hypothesis agree quite precisely with the observed ones. [Margin: De incurvatione lineæ itinerariæ, de Parallaxi, & diſtantiâ Cometæ à Terrâ.] *On the curvature of the line of travel, on the parallax, and on the distance of the comet from the Earth.* The latitudes, however, as with the preceding comets, consistently confirm that the trajectory displayed a certain curvature, swelling, namely, about its middle, but about its ends inclined toward the Sun, and straighter. As regards its distance from the Earth, Tycho asserts that it had a parallax scarcely a little greater than 1′, as can be learned from the letter and observation sent to the Landgrave in the year 1586, on March 1 [Calendis Martii]; that is, that this comet was about 2000 semidiameters of the Earth away from the Earth; at its disappearance, however, a parallax of scarcely half a minute was found, so that it was then far higher still. From our hypothesis and calculation, however, we found that the interval of the comet from the centre of the Earth, as is clear from the table appended, was 1603 semidiameters of the Earth at the beginning of the apparition; and that it thus showed a parallax of 2′; in the middle of its course, about the end of October, 1′; and about its exit only 50″, its distance from the Earth being, namely, 3788 semidiameters of the Earth. [Margin: Cur nullam oſtenderit caudam Cometa anno 1585.] *Why the comet of the year 1585 showed no tail.* Finally, as regards a beard or coma, it showed almost none; the reason is this, that its body was then situated opposite the Sun; but when it drew a little away from that opposition, namely on October 20 and 22, it presented a tail scarcely a span in length; and this likewise conforms to the rule of our diagram. Hence we clear our trajectory more and more of all absurdity, and it becomes manifest that this comet too obeys its laws.

Diagram. A full-page engraved plate, with no text on the page, carrying two figures on one copper: above, the theory of the comet observed by Tycho in the year 1585; below and to the right, the theory of the comet observed by Tycho in the year 1590. In the upper figure a fan of lines runs down from the top, each labelled near its upper end with a longitude. A long line runs down to the right from the upper left, carrying the points O, N, M, L, K, I, H, and is labelled beyond H as the trajectory of the comet. A large arc runs from a sign at its upper left round to the right through the lettered points G to A, with a sign at its right end and two further signs on it; dates stand below it beside dotted lines, from November 11 on the left to October 10 on the right. The

dotted lines converge below the arc on S, with a longitude beside it. Below that stands a horizontal line with dotted uprights above it, crossed by a sloping line, with letters above and below it. In the lower figure, five lines labelled with longitudes at their upper ends run down to the right and cross a line carrying the points X, M, L, K, I, H; a curve runs from a sign at its upper end down to the right through the points A to E, with a sign at its right end and another beside it; dates from February 23 to March 6 stand above A to E beside dotted lines, which converge above on S, with a longitude beside it; a long line rising from the lower left is labelled as the trace of the trajectory. At the foot stands a horizontal line with dotted uprights above it, crossed at its right end by a long line, with letters below it. The labels engraved on the plate:

- *Theória Cometæ Anno 1585 à / Tychone obſervati.* (title of the upper figure, near the top, right of centre): Theory of the comet observed by Tycho in the year 1585.
- Along the upper ends of the fan of lines, from left to right: 18° 15′. ♉; 15° 44′. ♉; 12° 40′. ♉; 8° 44′. ♉; 3° 43′. ♉; 27° 29 [?]. ♈ (the minute mark doubtful); 19° 38′ [?] ♈ (a point or a colon before the sign); 10° 3′. ♈; 29° 13′. ♓.
- Along the long line from the upper left: the points O, N, M, L, K, I, H; *Trajectoria Cometæ*., Trajectory, comet (beyond H, the second word printed in the nominative).
- The arc, from its upper left end: ♋ (at the upper left end); ♊; G; F; E; D; C; B; ♉; A; ♈ (at the right end).
- The dates below the arc, beside the dotted lines, from left to right: 11; 7; *3 Novembr*., November 3; 30; 26; 22; 18; 14; *10 Octobr*., October 10.
- Below the arc, where the dotted lines converge: S, with 28°. 15′. ♎ to its right.
- The horizontal line below that, from left to right: O, N, M (below the line); L, K (above it).
- *Theoria Cometæ Anno 1590 à / Tychone obſervati.* (title of the lower figure, at the right below the upper arc): Theory of the comet observed by Tycho in the year 1590.
- Below the second title, where the dotted lines of the lower figure converge: S, with ♓ 14° 10′ to its right.
- At the upper ends of the lines of the lower figure: 18° 27′. ♈ (from the upper right); 9° 11′. ♉, 21° 50′. ♉, 29° 44′. ♉, 3° 25′. ♊ (at the left, from top to bottom).
- At the upper end of the curve of the lower figure: ♌.
- The points of the crossing line, from lower left to upper right: X, M, L, K, I, H.
- Along the long line rising from the lower left: *Vestigium Trajectoriæ*., Trace of the trajectory.
- Beside the curve, below the crossing line: ♍.

- The dates above the points of the curve, from left to right: *23 Februar.*, February 23; 26; *1 Martii*, March 1; 4; 6.
- The points of the curve, from left to right: A, B, C, D, E, with ♎ at its right end.
- Foot of the plate, below the horizontal line, from left to right: M, L, K, I, H.
- *Fig. Z.* (lower left): Fig. Z.
- *Autor ſculpsit.* (lower right): Engraved by the author.

[Margin: Cometa ann 1590, quâ facie, caudâ & motu præditus fuerit ex obſervatione Tychonis.] *The comet of the year 1590: with what appearance, tail and motion it was endowed, from Tycho's observation.* And so I pass on to the comet of the year 1590. Although it was of very short duration and shone for scarcely half a month, from February 23 to March 6, it was nevertheless observed by Tycho with the greatest skill, as can be read in Tycho's letter [Epiſtolâ Tych.], p. 176. Yet nothing would have been more desirable than that it had remained visible longer, so that more certain [results] could have been obtained from its course and from a longer track of its path. From Aries, however, it advanced in longitude in a continuous course to Gemini, under a constant northern latitude. By its proper motion it likewise described the tract of a great circle, by this rule, namely, that at its first shining it covered 7½° a day, but at its last scarcely 1½°. Moreover, in Tycho's judgement, it was so far removed from us that he did not find a parallax of even a single 1′; indeed, it was scarcely perceptible. Finally, the tail, like the head, appeared larger and brighter at the beginning, to nearly 10°, than when the comet was already of a more advanced age, so that it gradually decreased afterwards.

[Margin: Quænam obſervationes pro calculo aſſumtæ fuerint.] *Which observations were taken for the calculation.* But let us now see whether all these things can be resolved equally conveniently by the trajectory line, with the help both of the diagram and of the calculation. For that purpose, therefore, we have taken all the longitudes for the days listed from observation, but the latitudes for February 23 and March 6. And so the trace of the trajectory cuts the annual orbit of the Earth in ♌ 14° 15′, and in the ecliptic it tends toward ♍ 1° 16′; the angle of the trajectory itself with the plane of the ecliptic is 26° 21′; the comet itself, however, is carried above all the sections, as the figure, the calculation and the table plainly show.

Feb. & Mar.	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)
	In the year 1590										
23	18° 27′ ♓	18° 14′ B.	18° 27′ ♓	18° 10′ B.	14° 10′ ♓	4° 17′	1502	1813	493	0	1581
26	9° 11′ ♉	20° 55′	9° 11′ ♉	20° 53′	17° 8′	52° 3′	1901	1343	725	524	2034
1	21° 57′	21° 15′	21° 50′	21° 17′	20° 6′	61° 44′	2446	883	953	513	2625
4	29° 44′ ♉	26° 58′ B	29° 44′ ♉	21° 1′ B.	23° 4′ ♓	66° 40′	3048	441	1171	493	3265
6	3° 15′ ♊	20° 46′	3° 25′ ♊	20° 46′	25° 3′	68° 22′	3452	162	1309	312	3692

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[Margin: Ex calculo & Schemate quævis phænomena hujus Cometæ rect[[è/e]] demonſtrantur.] *From the calculation and the diagram all the phenomena of this comet are correctly demonstrated.* Above all, it is clearly demonstrated that all the phenomena can be saved in a better way by means of the trajectory. For on our hypothesis the comet is continually direct; its apparent proper motion undergoes continual decrements; the head and the tail (although in fact they kept the same size throughout) decrease gently, while the comet, in its restless course, makes for higher regions. For the distance AH, where the phenomenon appeared at the beginning, is shorter than EM in its later

[601] The table has no title; it stands across the full measure of the body between two paragraphs, after the sentence that names it. It is ruled in twelve columns, in the same arrangement as the table of the comet of 1585 three pages earlier; the first carries the days, its head the abbreviations Febr. and Mar., joined by an ampersand and printed in three lines beside the row of the year, and the units are printed in a row of their own under the heads (Gr. M., Gr. Mi., degrees and minutes; Sem.T., semidiameters of the Earth), given here in brackets after each head. The row of the year, printed ANNO M. D. XC., spans the eleven columns to the right of the days. In the first column the month names are set sideways beside the days: Febr. M beside 23, 26 and 1, and artii. beside 4 and 6, the word Martii divided by the rule. Signs of the zodiac stand as printed, only where the page prints one; B. (borealis, north) stands as printed after the latitudes of February 23 and of March 4 (observed without a point, deduced with one), only where the page prints it. A rule across all columns divides the rows of March 1 and March 4.

position and that of the Earth. On our hypothesis this interval runs out to 3700 semidiameters of the Earth, so that at that time the parallax rises to scarcely 50″, but about the first origin of the comet to no more than two minutes: and on this account nothing at all is wanting in this comet. Fur- ther, its true proper motion in the trajectory was almost swifter than that of the preceding comet of 1585: about its entry, namely, 176 semidiameters of the Earth; but about its exit it was found to be only 154 semidiameters of the Earth. [Margin: Cometæ alii aliis modò funt velociores, modò tardiores, quoad motum proprium.] *Comets are now swifter, now slower, one than another, as regards their proper motion.* In this, however, these two comets differ from each other: in the latter, this true motion had much swifter decrements in an equal space of time. For in the former the motion slackened from its speed by only 4 semidiameters of the Earth, but in the latter by 22 semidiameters of the Earth, over an interval of ten days. For what reason, however, they do not each keep equal degrees of slowness and of speed in definite times will have to be investigated in its proper place. [Margin: Nec hujus Cometæ via Itineris ab omni inflexione fuit immunis.] *Nor was the path of this comet's course free from all bending.* Finally, the latitudes deduced from the hypothesis again prove the same thing: that the trajectory was not entirely straight but, like those of all the other earlier comets, was subject to some bending. If the comet had lasted longer, and the track of its path had been longer, this very thing would have struck the eye more clearly than from these five observations alone, namely from February 23 to March 6. We therefore conclude, in one and the same tenor, that in this comet too nothing at all occurs that is opposed to the trajectory motion, or that disturbs and destroys this theory of ours.

[Margin: De Cometâ anni 1607.] *On the comet of the year 1607.* I go on further to weigh and examine the comet of the year 1607 (since no other, as far as we have ascertained, has been duly observed by anyone since the year 1590 up to now): let us, I say, subject it to calculation in the same way as the earlier ones, and display its chief points in a table, together with a true delineation. For the calculation itself we have used Kepler's observations, namely the longitudes and the latitudes that he inserted in his little book on the same comet, p. 36; and in particular I applied to the calculation and the diagram the longitude on September 26 and 28 and on October 1, 10 and 19, but the latitude obtained on September 28 and October 19. The trajectory is set to coincide with the line of sight on October 4. The angle of obliquity of the trajectory to the plane of the ecliptic is 6° 8′; by this means the whole business will now be correctly settled. The said comet was observed, moreover, from September 25 to October 26, on the testimony of Kepler in the *Physiology of Comets*, p. 115: [Margin: Hiſtoria Cometæ 1607 à Keplero tradita.] *The history of the comet of 1607 as handed down by Kepler. The path along which it was carried appeared, from these lands, as very nearly a great circle; in its last days, however, it curved strongly toward the ecliptic. At the beginning it had a fairly large latitude, which, however, decreased from day to day; from ♌ as far as Sagittarius it always advanced in longitude with direct motion.*

On September 30 its daily motion was greatest, 13°, as much as the motion of the Moon, slower before and after, and always decreasing in order by smaller decrements; and finally, from the 19th to the 26th of October, as regards longitude, it showed the appearance of a station. [Margin: De motu & loco ejus.] *On its motion and place. The comet's path through the constellations was this: it arose under the fore foot of the Bear, grazed the belly of the Bear, and passed on and as it were cut through the middle of Boötes; from there it crossed into the constellation of the Serpent, and, having run through it in longitude, when it had begun to bend its course under the fore hand of Ophiuchus, it at last came out into his fore foot and stuck to the shin: nor do I think it reached the ecliptic, however long it might have lasted.* [Margin: Simul mane & veſpere obſervatus eſt hic Cometa.] *This comet was observed both in the morning and in the evening. And since its northern latitude was great at the beginning, it was seen both in the morning before the Sun and in the evening after the Sun. The head was at first of conspicuous size, but decreased from day to day, and then the tail too vanished toward the end.*

Sept. & Oct.	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)
	In the year 1607										
26	18° 30′ ♌	31° 30′ B.	18° 30′	36° 24′ ♍ B.	4° 27′ ♎	15° 57′	628	465	463	0	780
28	12° 0′ ♍	40° 4′	12° 0′	40° 5′ ♍	6° 25′	24° 25′	564	570	475	106	738
Oct. 1	17° 20′ ♍	37° 0′	17° 0′	36° 41′ ♎	9° 23′	7° 37′	663	741	494	172	827
4	8° 5′ ♏	29° 0′ B.	8° 0′	28° 49′ ♏ B.	12° 21′ ♎	25° 39′	936	936	515	196	1068
7	18° 40′	23° 30′	18° 50′	22° 37′	15° 19′	33° 31′	1294	1162	539	227	1402
10	24° 50′	19° 0′	24° 50′	18° 26′	18° 17′	36° 33′	1701	1422	567	262	1793
13	27° 57′	15° 30′ B.	28° 24′	15° 37′ B.	21° 15′	37° 9′ ♎	2142	1720	599	300	2233
16	0° 24′ ♐	13° 36′	0° 31′	13° 37′ ♐	24° 13′	36° 18′	2620	2060	635	342	2696
19	2° 0′	12° 0′	1° 45′	12° 10′	27° 12′	34° 33′	3144	2460	678	402	3216
22	1° 54′	9° 45′ B.	2° 11′	11° 3′ B.	0° 11′ ♏	32° 0′	3738	2950	730	493	3809
25	1° 38′	7° 0′	1° 51′	10° 10′	3° 11′	28° 40′	4450	3580	798	633	4521

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[Margin: Inquiritur,an calculus & Schema obſervationi ab omni parte reſpondeat?] *It is asked whether the calculation and the diagram answer the observation in every respect.* I have no doubt at all that all these things, together with any that may perhaps have been noticed besides by someone, can be defended and demonstrated precisely with the help of our diagram and by the theory. First, it can be seen from the following figure, A A, that the comet was continually direct. Second, since the trace of the comet's path cuts the plane of the ecliptic at a fairly obtuse angle, and very close to the Earth, stretching itself out toward the Sun, the comet was therefore much nearer the Earth at its entry than at its exit; and so too its head and tail were larger and more evident then than at the time when it was being removed further from the Earth [and] was again approaching the Sun. Next, because the visual rays cross at a greater angle at the beginning, its apparent motion too therefore quickened its speed more at the beginning than in the middle. [Margin: Quo tempore,& quamdiu ſtationarius deprehenſus fuerit.] *At what time, and for how long, it was found stationary.* Likewise, when the Earth went on from A toward D, E, F, to more remote parts, crossing the trace itself, it could not have happened otherwise than that the comet was seen continuously stationary from the 19th to the 26th of October, according to Kepler's notes, and parallel to the course of the lines of sight. Moreover, if the comet had lingered somewhat longer in the heavens, it would have been forced to go retrograde, according to our axioms, to be set out a little later: for at the beginning it advanced above the crossings of the sections, but afterwards, having completed some stretch of its path, below them, as the diagram and the calculation show.

[Margin: Cometa 1607 ſub finem ſemitam ſuam inflexit Solem versùs.] *Toward the end, the comet of 1607 bent its path toward the Sun.* That the comet did not follow a great circle in a continual course, but at the last turned obliquely toward the ecliptic, we maintain no less fittingly by the diagram and the calculation. For since the latitudes deduced from the theory and its numbers came out smaller than the observed ones at the beginning, but larger at the end, the trajectory acquired, for necessary reasons, a curvature toward the

[602] The table has no title; it stands across the full measure of the body at the head of the page, before the paragraph that discusses it. It is ruled in twelve columns, in the same arrangement as the tables of the comets of 1585 and 1590 on the preceding pages; the first carries the days, its head the abbreviations Sept. and Oct., joined by an ampersand and printed in three lines beside the row of the year, and the units are printed in a row of their own under the heads (Gr.M., degrees and minutes; Sem.T., semidiameters of the Earth), given here in brackets after each head. The row of the year, printed ANNO M. DC. VII., spans the eleven columns to the right of the days. In the first column the abbreviation Sep. is set sideways beside 26 and 28, and the row of October 1 prints Oct.1 on one line. Signs of the zodiac stand as printed, only where the page prints one; B. (borealis, north) stands as printed after the latitudes of September 26, October 4, 13 and 22, only where the page prints it. Rules across all columns divide the rows of October 1 and 4, 10 and 13, and 19 and 22; a short rule stands under the elongation of September 28 only.

Sun. [Margin: Cometa longè altiorLun[[â/á]] extitit, in fine verò etiam Solem ſupergreſſ9 eſt; tam juxta Kepleri obſervationem,quàm noſtramTheoriã.] *The comet was far higher than the Moon, and at the end it even passed beyond the Sun, according both to Kepler's observation and to our theory.* Moreover, as Kepler would have it, the comet moved from its rising far higher than the abodes of the Moon, as he clearly asserts on p. 41 in his description of this comet; indeed, if we believe him when he testifies in the same place, p. 6, it was four times higher than the Moon, so that toward its setting it even surpassed the very distance of the Sun: which likewise the delineation and the calculation of ours neatly grant. For on 26 September, by our hypothesis, it was 780 semidiameters of the Earth away; continually making for more remote regions, it was at last removed 4500 semidiameters of the Earth, at almost the same distance as the Sun itself — on our view, that is, supposing a solar parallax of 40″, or a distance of the Sun of 5157.

[Margin: Hic Cometa ferè omnium,quà motum proprium,fuit tardiſſimus.] *Of nearly all comets, this one was the slowest in its proper motion.* As for its proper motion in the trajectory, the comet advanced at a very hesitant pace, and was indeed more sluggish than all the earlier ones set aside for calculation, if you except only the comet of Regiomontanus. For from its origin, namely on 27 September, it moved on only 52 semidiameters of the Earth, whereas the rest, by contrast, were twice and indeed three times as swift, as above all the comets of 1585 and 1590 proved to be. [Margin: Motus verò incrementa fuerunt velociſſima.] *But the increments of its motion were very swift.* Again, however (and this must be noted above all as something singular and unusual), the motion of this comet gained very swift and continuous increments from day to day, indeed far swifter than the course of any other comet. For when its journey was nearly run, namely at the end, that motion grew to 220 semidiameters of the Earth, so that within the space of one month it had quickened its course by as much as 158 semidiameters of the Earth. [Margin: Non in omnibus Cometis cursûs incrementa ſunt æqualia; ſed longè diverſa.] *The increments of the course are not equal in all comets, but widely different.* By contrast, in some comets, over an equal interval of time, the speed exceeded [its earlier rate] by scarcely 20 semidiameters of the Earth, as happened in the comets of 1532 and 1590. In others, as was found in the comet of 1577, by scarcely 12; and in the comet of 1585 that true proper motion was intensified by not even 5 semidiameters of the Earth. This certainly arouses no ordinary wonder: namely, that this motion varies so marvellously in comets. It will therefore deserve to be weighed more deeply in its proper place — that is, whether the reasons for this phenomenon can be correctly uncovered; and that this can be done, with God's favour, I by no means doubt.

[Margin: Quare cauda atq; caput in dies valdè decreverint.] *Why the tail and the head decreased greatly from day to day.* As for the rest, it clearly shows that this same comet was first a morning comet and afterwards an evening one (nor on this point does the hypothesis err in anything at all); then, that it directed

its course through all the recorded constellations; and no less, that its head and tail decreased markedly every day. The reason is plain: since the phenomenon withdrew from the Earth more and more in an almost straight line and made for the Sun, it was compelled by necessity to put on one most conspicuous appearance after another. So nothing at all remains that cannot be explained, defended and demonstrated by this theory of ours — and that of its own accord, and in keeping with the nature of the thing. Let this, too, suffice concerning the comet of the year 1607.

[Margin: Cometa 1618 quot diebus fuerit conſpicuus.] *For how many days the comet of 1618 was visible.* This was followed by that celebrated and most brilliant comet of the year 1618, which offered itself to view for 55 whole days, from 24 November to 18 January, and was carried along nearly under a great circle; yet in such a way that it completed unequal apparent daily motions, first increasing in a definite order, then gradually decreasing again. [Margin: A circulo maximo ſub occaſum, Auſtrum versùs deviavit.] *Toward its setting it strayed from the great circle toward the south.* At the end, however, it deflected a little from this great circle toward the south. At the beginning its head was much larger and more splendid than in the course of time. Likewise, from its earliest days it sustained a very long train [Comam]; in particular, on 9 December (as Kepler attests) it equalled, indeed exceeded, a length of 70 degrees. [Margin: Quanta fuerit caudæ longitudo.] *How great the length of the tail was.* Through which asterisms this hairy star made its way, and beside which stars it stood on each day, you will learn from elsewhere, above all from our History of Comets, to be appended at the end of this work. Whether each of these points obeys the laws of the trajectory without distinction will now be shown forthwith.

Diagram. A full-page engraved plate, with no text on the page, carrying two figures on one copper: above, the theory of the comet observed by Kepler and Longomontanus in the year 1607; below, the theory of the comet observed by Cysat in the year 1618. In the upper figure a fan of lines runs down from the upper left, each labelled along its length with a longitude, and a line labelled as the trace crosses them. A long line runs down to the right through the points N, M, L, K, I, H. An arc runs from a sign at its left end round to the right through the lettered points A, B, X, C, D, E, F to a sign at its right end, with a further sign on it near that end; dates from September 26 to October 25 stand above it beside dotted lines, which converge above on S, with a longitude beside it. A line labelled with an abbreviation of the word trajectory runs down through X. At the left stands a horizontal line with dotted uprights below a sloping line, with letters below it. In the lower figure, lines labelled with longitudes at their left ends run across from the left side and the lower edge, and a line labelled as the trace runs among them; a long line runs down to the right through the points O, N, M, L, K, I, H; a curve runs from a sign at its right end to the left through the points A, B, C, D, E, F, G, with two further signs beside it; dates from December 1 to January 22 stand below it beside dotted lines, which converge below on S, with a longitude beside it; a long line at the lower right

is labelled as the trajectory. At the foot stands a horizontal line with dotted uprights above it, crossed at its right end by a long line, with letters below it. The labels engraved on the plate:

- *Theoria Cometæ Anno 1607 à Keplero / et Longomontano obſervati.* (title of the upper figure, at the upper left): Theory of the comet observed by Kepler and Longomontanus in the year 1607.
- At the top, right of centre, where the dotted lines of the upper figure converge: S, with ♎ 4° 27′ to its right.
- Along the lines of the fan of the upper figure: 18° 50′. ♏ (the uppermost); ♐ 2° 11′, 1° 45′. ♐, 0° 31′. ♐, 1° 51′. ♐ (along the group of closely set lines below it); 8° 0′. ♏; 17° 0′. ♎; 12° 0′. ♍; 18° 30′. ♌ (the last three at the right, reading downward and turned over); 28 24. ♏ (printed without degree and minute marks) and 24° 50′. ♏ (lower in the group, at the left).
- Along a line crossing the fan: *Vestigium*, Trace.
- Along the long line of the upper figure, from upper left to lower right: N, M, L, K, I, H.
- The arc, from its left end: ♈ (at the left end); A; B; X; C; D; E; F; ♉; ♊ (at the right end).
- The dates above the arc, beside the dotted lines, from left to right: *Sept. 26*, September 26; 28; *Oct. 1*, October 1; 4; 7; 10; 13; 16; 19; 22; 25.
- Along the line through X, reading downward: an abbreviation of the word trajectory, its middle letters not settled [?] (line F40).
- The horizontal line at the left of the upper figure, below it from left to right: N, M, L, K, I, H.
- Along the lines of the lower figure, at their left ends, from top to bottom: 24° 17′. ♋; 1° 44′. ♌; 11° 30′. ♌; 23° 30′. ♌; 8° 25′. ♍; 20° 2′. ♍; 1° 6′. ♎; 10° 59′. ♎; 17° 42′. ♎; 23° 56′. ♎; 29° 38′. ♎; 4° 47′. ♏; 9° 24′. ♏.
- Along a line between the second and third of these: *Vestigium*, Trace.
- Along the long line of the lower figure, from upper left to lower right: O, N, M, L, K, I, H.
- The curve, from its right end: ♊ (at the right end); A; B; C; D; ♋ (above the curve, between D and E); E; F; G; ♌ (beside the curve, below G).
- The dates below the curve, beside the dotted lines, from right to left: *Decemb. 1*, December 1; 4; 7; 10; 13; 16; 20; 24; 28; *Januar. 2*, January 2; 7; 12; 17; 22.
- Along the long line at the lower right: *Trajectoriæ.*, Of the trajectory.
- Below it, where the dotted lines of the lower figure converge: S, with 9° 26′. ♐ to its right.
- *Theoria Cometæ Anno 1618 / à Cÿſato obſervati.* (title of the lower figure, below S): Theory of the comet observed by Cysat in the year 1618.
- Foot of the plate, below the horizontal line, from left to right: O, N, M, L, K, I, H.
- *Fig. AA.* (at the right, above the foot line): Fig. AA.

• *Autor ſculpsit.* (lower right): Engraved by the author.

But no slight weight would be added to our undertaking if this comet — [Margin: Vt ut hic Cometa inter præcipuos merito numeratur; ſatis tamen exquiſitè, uti quidem debuiſſet,haud obſervatus eſt.] *Although this comet is rightly counted among the foremost, it was not observed with enough care, as indeed it ought to have been.* just as it is rightly counted among the foremost comets born since the beginning of the world, so too it shone at a time when a great many most learned and eminent mathematicians flourished — had been observed by those very men, as indeed they could have done, absolutely perfectly in every respect and with the help of larger and most trustworthy instruments. But it must be admitted (and I would wish this to be said without prejudice to anyone's reputation) that, far from its having been noted precisely enough (as this extremely subtle business indeed demanded), in longitude as in latitude, much greater diligence would even have been needed. [Margin: Etiam correctiores obſervationes hujusCometæ nonnihil vacillant.] *Even the more correct observations of this comet waver somewhat.* For, to touch only on the chief observations (leaving aside all the other, lesser ones), and above all those of Joh. Bapt. Cysat, than whom no one has left us better, as Kepler admits, I do not hesitate at all to affirm that among them a great many quite unsteady ones are found, even among those which the said author counted among the more correct. From this we rightly recognize that his observations waver somewhat. Whether the fault in this matter lies in the instruments or rather in the observers, I leave undecided on this occasion; [Margin: Ob loca hujus Cometæ ex parte dubia, Theoria ad debitam præciſionem deduci haud potuit.] *Because the places of this comet are partly doubtful, the theory could not be brought to its due precision.* I assert only this: that because of the doubtful longitudes and latitudes of this comet in the year 1618, the business cannot be brought to its due precision if it has to be set out to within one or two minutes. Yet this could be done very easily if the places of the comet, and above all the distances, had been taken from the sky quite exactly. I have had to point this out here for this very reason: so that in future no one else — a more careful investigator of these matters, or any other detractor — on finding that this computation of ours departs a little from the observations now and then, should at once ascribe it either to our hypothesis or to the calculation, but should impute it solely to those unsteady data. For unless so subtle a business rests on the firmest and most certain observations, nothing solid at all is deduced. [Margin: Cyſatum in quibusdam hallucinatum fuiſſe, luculenter commonſtratur.] *It is clearly shown that Cysat erred in some respects.* But so that words should not have to serve where deeds are needed, I shall at once show in fact that no slight errors crept upon Cysat while he was observing, from wherever they may have arisen; although I am sure that, besides these, some were committed in the calculation itself as well.

Notes on the Comet of the Year 1618 Observed by Cysat [Annotationes de Cometâ An. 1618 à Cysato obſervato.]

December 1.

$5^h\ 45^m$	From the distance of the comet from Arcturus	27° 6′	
	from Spica	24° 48′	
	its longitude comes out	9° 22′	♏
	latitude	11° 37′	*Bor.*
$6^h\ 56^m$	From the distance of the comet from Arcturus	26° 56′	
	from Spica	24° 54′	
	the longitude comes out	9° 34′	♏
	latitude	11° 50′	*Bor.*

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[Margin: Obſervationes Cyſati, die 1. Decemb. oſtendunt Cometam directum; cùm tamen reverà retrogradus extiterit.] *Cysat's observations of December 1 show the comet direct, although in fact it was retrograde.* Yet it is certain that the comet was retrograde; hence some fault must necessarily underlie these observations, by which it would have been direct. But the fault must lie in Cysat's calculation, who at $6^h\ 56^m$ set the longitude of the comet, from the observation cited, at ♏ 9° 22′, whereas in fact it is 12′ greater.

December 10.

$6^h\ 25^m$	From the distance of the comet from the bright star of the Crown	13° 44′
	from the last star in the tail of Ursa Major	29° 26′
	the longitude is found	23° 37′ ♎
	latitude	35° 9′ *B.*
	But with the comet's place set from this, its distance is computed from the unformed star under the tail of the Bear	28° 29′
	from the bright star of Lyra	53° 40′
	Cysat observed the former, in Kepler, as	28° 4′
	but the latter as	53° 3′

603 On the page this is an unruled display in small italic type, set within the body under the date line, with no column heads: the hour and minutes at the left of the first line of each observation, the wording in the middle, set to the right in steps, and the degrees and minutes at the right. The page prints a degree mark and a minute mark only on the first distance (27° 6′); the other values print the two figures alone, given here as degrees and minutes. The sign and the abbreviation *Bor.* (borealis, north) stand only where the page prints them.

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[Margin: Cyſatus Die 10 Decembr. nimiùm ſanè aberravit.] *On December 10 Cysat erred far too much indeed.* The first difference, 25, and the second, 37 minutes, are too great. And although Cysat does not count these observations among his own, as being doubtful, yet how could an observer who now and then strays so enormously find credit? But even among Cysat's approved observations, equally bad ones are not lacking.

December 17.

$4^h\ 7^m$	From the distance of the comet from the leading star before the bend of Draco	28° 54′	
	from the last star in the tail of Ursa Major	12° 3′	
	the longitude comes out	9° 31′	♎
	northern latitude	49° 39′	

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[Margin: Intolerabilis hæc diſcrepantia, pen[[è/é]] omnẽ fidem his obſervatis derogat.] *This intolerable discrepancy takes away almost all credit from these observations.* From the same observation Cysat indeed assigns the comet a longitude of ♎ 8° 49′ and a latitude of 49° 20′. But between this latitude of the comet and that of the star before the fourth bend of Draco, which makes a straight line with the shoulder and breast of Ursa Minor, 78° 32′, there lie 29° 12′. It is plain, then, that either the comet's latitude is faulty or the observed distance of 28° 54′ is not right, since it cannot be less than the difference of the latitudes. However, with the comet's place correctly set from that observation, its distance is found as follows:

from Arcturus	19° 55′
from the bright star of the Crown	19° 16′
from the unformed star under the tail of the Bear	17° 55′
from the one that follows the third bend of Draco	35° 15′

But Cysat, too, among his approved observations, reports the distance of the comet:

[604] On the page this is an unruled display in small italic type, set within the body under the date line, with no column heads: the hour and minutes at the left of the first line, the wording in the middle, set to the right in steps, and the degrees and minutes at the right. The page prints a degree mark and a minute mark only on the first distance (13° 44′); the other values print the two figures alone, given here as degrees and minutes. The sign and the abbreviation *B.* (borealis, north) stand only where the page prints them. The last pair of figures stands a little below the line of its words.

[605] Set as the display of December 10, with no column heads; the page prints a degree mark and a minute mark only on the first distance (28° 54′), and the sign only where shown.

from Arcturus	19° 48′
from the bright star of the Crown	19° 42′
from the unformed star under the tail of the Bear	16° 2′
from the said star of Draco	35° 30′

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Of the two middle distances, the first observed exceeds the calculation by 26 minutes, while the other falls short by 1° 53′ — an intolerable discrepancy, which quite rightly seems to take away all credit from these observations.

December 28.

[Margin: Certum indicium circa obſervationes aberratum eſſe.] *A sure sign that there was error in the observations.* With the comet's place set at ♏ 8° 30′, with a latitude of 60° 57′, from its distance from the shoulder of Ursa Minor, 16° 39′, and from the back of Ursa Major, 11° 42′, its distance from Arcturus is found to be 39° 52′, and from the side of Ursa Major 20° 13′. Cysat gives the former 8′ greater and the latter 15′ smaller, from an observation which, as he admits, was less accurate.

January 12.

At 8^{h} in the evening, from the distance of the comet from the shoulder of Ursa Minor, 12° 21′, and from the first star in the tail of Ursa Major, 18° 12′, Cysat derives its longitude as ♌ 1° 7′ and its latitude as 59° 47′. [Margin: Calculo rectè poſito, latitudo Cometæ ad integrum penè gradum major evadit.] *When the calculation is set up correctly, the latitude of the comet comes out greater by almost a whole degree.* But if the calculation is made faithfully from Tycho's longitudes of those fixed stars, the true longitude of the comet will come out ♌ 1° 16′, the latitude 6° 44′. And so, since Cysat's observations do not agree among themselves wherever several can be compared with one another, not even then, when still bright enough, the comet was: what, then, will seem to be granted to them where the comet, with a dim light, let itself be seen only by those with keen sight?

[Margin: Ex quibus; quid tribuendum ſit nonnullis obſervationibus Cyſati, facilè colligitur.] *From which it is easily gathered what is to be granted to some of Cysat's observations.* You see, then, kind reader, how matters stand even with those observations that are reputed the more accurate, so that anyone may readily judge how much may be drawn from them, and how far one can go. Nevertheless, lacking better and more certain ones, we must use these on this occasion — separating, however, the somewhat more accurate from the less correct, and applying the file to the others as well — so that access to the

[606] Both lists are set on the page as unruled displays in small italic type, with no column heads, the names of the stars in the middle and the degrees and minutes at the right; the page prints a degree mark and a minute mark only on the first distance from Arcturus (19° 55′). The first list carries the end of the sentence before it; the second follows the italic line that introduces it.

investigation may thus lie open the more easily. For the calculation, and for constructing our theory, we took the longitude of the comet on December 1, 20 and 28 and January 2, and its latitude on December 1 and 20. [Margin: Quibus obſervationibus Schema & calculus nitatur.] *On which observations the diagram and the calculation rest.* The trace of the trajectory cuts the annual orbit at the place of the Earth on 9 January, that is, in ♋ 19° 0′, and in the ecliptic it tends toward ♌ 9° 20′. The angle of obliquity of the trajectory to the plane of the ecliptic is 41° 5′. From these I have now set up the preceding diagram, and with due diligence derived the following numbers.

Dec. & Jan.	Observed longitude of the comet (deg. min.)	Observed latitude of the comet (deg. min.)	Longitude of the comet deduced from the hypothesis (deg. min.)	Latitude of the comet deduced from the hypothesis (deg. min.)	Longitude of the Sun (deg. min.)	Elongation of the comet from the Sun, or conversely of the Sun from the comet (deg. min.)	Distance of the perpendicular from the comet on to the trace, from the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trajectory (semidiameters of the Earth)	Altitude of the same perpendicular (semidiameters of the Earth)	True motion of the comet in its trajectory (semidiameters of the Earth)	Interval of the comet from the centre of the Earth (semidiameters of the Earth)
	In the year 1618										
1	9° 24′ ♏	40° 40′ B.	9° 24′ ♏	11° 0′ B.	9° 26′ ♐	0° 2′	2760	2260	536	0	2712
4	4° 59′	19° 13′	4° 47′	19° 30′	12° 27′	37° 40′	2611	1816	925	590	2770
7	29° 25′ ♑	32° 29′	38′ ♒	7° 49′	15° 28′	45° 50′	2468	1384	1302	574	2790
10	23° 40′ ♒	2′ 23° 56′ B.	♓	5° 32′ B.	18° 28′	54° 32′	2337	965	1669	556	2872
13	17° 30′	41° 50′	17° 42′	42° 16′	21° 29′	63° 47′	2222	563	2020	534	3003
16	11° 0′	47° 50′	10° 59′	48° 4′	24° 29′	73° 30′	2116	179	2356	510	3166
20	1° 6′ ♓	54° 18′ B.	1° 6′ ♓	54° 7′ B.	28° 30′	87° 24′	2012	307	2781	646	3433
24	20° 5′ ♍	59° 43′	20° 2′ ♍	58° 23′	2° 31′ ♑	102° 29′	1966	780	3194	628	3750
28	8° 25′	60° 58′	8° 25′	60° 58′	6° 33′	118° 8′	1995	1239	3595	610	4111
2	23° 30′ ♎	62° 36′ B.	23° 30′ ♎	62° 39′ B.	12° 6′ ♑	138° 36′	2109	1791	4078	733	4590
7	11° 38′	62° 28′	11° 30′	62° 31′	17° 8′	155° 38′	2340	2271	4498	638	5070
12	1° 7′	59° 47′	1° 44′	61° 26′	22° 9′	170° 25′	2670	2736	4904	618	5583
17	25° 40′ ♌	17′ 24° 17′	♌	59° 43′	27° 9′	182° 52′	3095	3191	5302	604	7241

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Thus the trace of the comet passes very near the Sun, and as time goes on it departs from it more and more, almost in a straight line, toward the opposite parts: [Margin: Veſtigium Cometæ an.1618, continenter à Sole diſcedit.] *The trace of the comet of the year 1618 continually departs from the Sun.* exactly the contrary of what happened in the comet of 1607, which continually, in a not dissimilar way, hastened toward the Sun. The trajectory, however, runs above the trace at a quite remarkable interval, because of the very large latitudes, of 60 degrees and more, around the end of the appearance. [Margin: Quare longitudo initiò vix pauxillum variata fuerit.] *Why the longitude at first varied scarcely at all.* From the very beginning the lines of sight nowhere met one another crosswise, either below or above the trajectory, but up to 24 December they stood spread apart, as is clear from the diagram; and this was the reason why the longitude then varied very little. After that, however, the said lines of sight crossed one another first below the trajectory, and afterward above it (once the Earth had passed the trace). [Margin: Cur motus longitudinis in fine longè velocior extiterit.] *Why the motion in longitude was much faster at the end.* Hence it also came about that, while the lines of sight met crosswise below the trajectory, the motion in longitude was much faster than when the lines of sight were spreading apart at the beginning, or even when, at the last, they came together and converged above the trajectory.

[Margin: Quare motus apparens tardus, licet verus ſatis velox, extiterit.] *Why the apparent motion was slow, although the true one was quite swift.* Nor is the reason unlike, too: since the Earth stood almost perpendicular, with respect to the trace of the trajectory, at A, and afterwards advanced together with the comet in almost the same course and toward the same region of the heavens, it came about from this that the apparent motion appeared rather slow, although the comet's own true motion enjoyed a notable speed — of which more fully below. But if the comet had set its course in the direction opposite to that of the Earth, it is wonderful how much the apparent motion would have been accelerated. Again, however, when the Earth was at E, F, G, nearer to the trace, that proper motion was seen to be far slower still; especially considering that

[607]The table has no title; it stands across the full measure of the body between the paragraph that introduces it and the paragraph that discusses it. It is ruled in twelve columns, in the same arrangement as the table of the comet of 1607 two pages earlier; the first carries the days, its head the abbreviations Dec. and Jan., joined by an ampersand and printed in three lines beside the row of the year, and the units are printed in a row of their own under the heads (Gr.M., degrees and minutes; Sem.T., semidiameters of the Earth), given here in brackets after each head. The row of the year, printed ANNO M. DC. XVIII., spans the eleven columns to the right of the days. In the first column the month names Decem. and Januarii. are set sideways, Decem. beside the days 1, 4 and 7, Januarii. beside 2, 7, 12 and 17; the rows from 1 to 28 are December, the rows from 2 to 17 January. Signs of the zodiac stand as printed, only where the page prints one; B. (borealis, north) stands as printed after the latitudes of December 1, 10 and 20 and January 2, only where the page prints it. Rules across all columns divide the rows of December 7 and 10, 16 and 20, and 28 and January 2.

the trajectory at that time had already been raised very high, and that the comet had gone off, as if directly, further beyond the Earth and the Sun, toward N and O.

Moreover, no less from our hypothesis and calculation do we understand why [Margin: Ratio,cur à recto itinere ſub finem deflexerit Cometa.] *The reason why the comet turned aside from a straight path toward the end.* the trajectory deviated somewhat toward the south, from a straight path, or great circle, around the time of the comet's decline: namely, because the latitudes from our hypothesis are greater at the end than those observed, where the comet had reached so great a distance from the ecliptic — and indeed for at least two reasons, which are to be kept for their proper place. Next, you ask why, between 7 and 10 December, the head was brightest, and above all the tail longest, compared with all the other days? [Margin: Cauſa, ob quam cauda, inter diem 7 & 10 Decemb. adeò longa extiterit.] *The cause on account of which the tail was so long between 7 and 10 December.* For this reason, I think: that at that very time, at B, the comet was nearest to the Earth. But if you infer that the comet, when the Earth was at E, F and G, was less far from it than at B and A — since EM and FL are far shorter than BI and AH — then indeed one must distinguish carefully here between the distance of the Earth along the perpendicular line descending from the comet onto the trace (which distance is that very line which you say is shorter), and, on the other hand, the interval of the comet itself from the centre of the Earth. With the Earth at B (since the trajectory is raised above the trace by more than 41°), this interval was far smaller, above all because the latitude at that time was almost half as small as when the Earth was at F. Therefore the interval between the comet and the Earth at F was also much greater, and consequently the comet's head and tail also appeared far smaller and dimmer. [Margin: Diſtantia à Terrâ Cometæ anni 1618.] *Distance from the Earth of the comet of the year 1618.* This very thing our calculation, that is, the preceding table, now also plainly proves. Its last column shows that on 7 and 8 December, namely, when the Earth was at B, the interval of the comet from the centre of the Earth stood at only 2800 semidiameters of the Earth; but again, when the Earth was at F, it even exceeded 5000 semidiameters of the Earth. And so in this position the comet was removed from the Earth by an almost twice greater distance, and of necessity on 8 December it shone the greatest of all, and conspicuous, both in its head and in its tail; which was to be demonstrated.

Furthermore, from these computed intervals it is easy to judge the parallaxes approximately. [Margin: Quanta fuerit parallaxis hujus Cometæ.] *How great the parallax of this comet was.* At the beginning the parallax was not more than 1½′; that is, the comet stood not below half the interval of the Sun from the Earth. Around the end of the appearance, however, that same parallax was found to be only 30″, so that the comet exceeded the Sun itself in remoteness. But, you will say, how so? [Margin: Non omni Cœli loco Trajectoriam deſcribere poſſumus.] *We cannot describe the trajectory in every place of the heavens.* Did you

not build the theory of your own accord and enter upon the calculations, so that you can also determine them [the parallaxes] at your pleasure? I do not deny that I assumed a hypothesis in order to demonstrate a motion in an almost straight trajectory; but you are far mistaken in that opinion. For I would have you know, as already touched on above, at p. 591: that [we] can by no means, just as the fancy takes us, draw and suppose the trajectory in any place whatever of the diagram and of the heavens — whether under a smaller or a larger angle of inclination, either stretched out toward the Sun or receding from the Sun at this or that angle. Rather, we are compelled by the utmost necessity to place it in exactly that place where the comet actually drew its course. Just as the comet marked out this line of travel [lineam apodemicam] by its course in only one definite place of the heavens, so indeed it can be described only in one place of the diagram that belongs to it and duly corresponds to the motion. [Margin: Plurimùm intereſt ritè ſupponere Trajectoriam.] *It matters very greatly to suppose the trajectory correctly.* The true position of this line, however, is not obtained without much labour, as we have already said a little before. For if in the diagram you stray from the comet's genuine course in the heavens, supposing that path either too near the Earth or far from it, then, believe me, neither the apparent motions nor all the remaining phenomena will agree by any means; on the contrary, you will stir up the greatest confusion and disturbance of everything. But once the trajectory has been laid down correctly and duly, and indeed to the point that the whole motion corresponds exactly, then, I say, the parallax of the comet emerges approximately of its own accord from the computed interval of the comet from the centre of the Earth.

[Margin: Quà motum proprium hic Cometa omnium velociſsim9 fuit.] *In respect of proper motion this comet was the swiftest of all.* Finally, as regards its true proper motion, this comet was the swiftest of all the others that have been mentioned above — namely, near the beginning of its appearance — although its apparent daily [motion] was found to be only 3°, while that of the others grew to 10, 12 and 15 degrees, indeed to 40°, like Regiomontanus's. For its true motion in its trajectory on 2 December was 198 semidiameters of the Earth; yet it decreased gradually day by day, until around its extinction it had slackened to 120 semidiameters of the Earth. [Margin: Cometæ diverſos gradus accelerationis & retardationis exhibent.] *Comets show different degrees of acceleration and retardation.* But the decreases of this comet were far slower and gentler than the increases of that other one in the year 1607: for the latter accelerated its motion, in the space of one month, by 170 semidiameters of the Earth, whereas that of the year 1618 slowed by scarcely 65 semidiameters of the Earth. Yet whatever degrees of acceleration and retardation all those comets may have had which I wished on this occasion to set out in a trajectory by means of this hypothesis of ours, everyone ought to be persuaded that that same motion, of any comet whatever, either grows or diminishes in order and fittingly, as it should, and never at all becomes disordered and irregular, however truly wonderful the changes that the apparent motion may have shown.

[Margin: Vnde certitudo pateat noſtræ Theoriæ.] *From which the certainty of our theory may be evident.* This is clear proof that this theory of ours is by no means doubtful, but most agreeable to nature and to the phenomena — about which, however, we shall treat more fully hereafter. [Margin: PerEccentricos nullâ planè ratione phanomena Cometæ 1618 ſalvantur.] *By eccentrics the phenomena of the comet of 1618 are saved in no way at all.* For now I shall add only these few remarks by way of a makeweight: that each and every phenomenon of this comet of 1618, and also its continual progression against the order of the signs, can be saved as well as possible by a trajectory — which, indeed, you will by no means achieve by circular paths, however laboriously you devise infinitely many and most ingenious eccentrics and epicycles and carry the comet upon them; and the most acute Kepler agrees with us in *Histor. Cometarum*, p. 85.

Having thus demonstrated by means of the trajectory, in our manner, all those comets of earlier times that were set aside for this undertaking of ours, we at last return to our comet of the year 1652, observed by ourselves (be it said without boasting) with due diligence. [Margin: Occaſione Cometæ an. 1652 totus hic labor Cometographicus initus eſt.] *This whole cometographic labour was undertaken on the occasion of the comet of the year 1652.* It was for its sake that everything this work contains, whatever it may be, was undertaken by us deliberately.

Table Showing the Main Points of the Calculation [Tabula Calculi Capita exhibens.]

At midnight, as the day ends, New Style	Observed longitude of the comet	Observed latitude of the comet	Longitude of the comet deduced from the hypothesis	Latitude of the comet deduced from the hypothesis	Eccentric longitude of the Sun	Elongation of the comet from the Sun	Angle of the trajectory's trace with the lines of sight of the comet's longitudes
December	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.	Deg. Min.
14			8° 49′ ♋	74° 17′ A.	24° 0′ ♐	*SQT* 194° 49′	*XTQ* 56° 20′
15			2° 29′	69° 48′	25° 0′	187° 29′	62° 40′
16			26° 4′ ♊	64° 17′	26° 0′	180° 4′	69° 5′
17			20° 20′ ♊	57° 17′ A.	27° 0′ ♐	*SPR* 173° 20′	*XRP* 74° 49′
18			15° 28′	48° 48′	28° 0′	167° 28′	79° 41′
19			11° 5′	39° 6′	29° 0′	162° 5′	84° 4′
20	7° 27′ ♊	28° 19′ A.	7° 20′ ♊	28° 39′ A.	0° 0′ ♑	*SAH* 157° 20′	*XHA* 87° 49′
21	3° 47′	17° 38′	4° 6′	18° 28′	1° 0′	153° 6′	91° 3′
22	1° 3′	8° 43′	1° 18′	9° 22′	2° 1′	149° 17′	93° 51′
23	28° 53′ ♉	1° 19′ A.	29° 3′ ♉	1° 35′ A.	3° 1′ ♑	*SBI* 146° 2′	*XIB* 96° 6′
24	27° 8′	4° 47′ B.	27° 14′	4° 45′ B.	4° 1′	143° 13′	97° 55′
25	25° 41′	9° 50′	25° 43′	9° 46′	5° 1′	140° 42′	99° 26′

At midnight, as the day ends, New Style	Observed longitude of the comet	Observed latitude of the comet	Longitude of the comet deduced from the hypothesis	Latitude of the comet deduced from the hypothesis	Eccentric longitude of the Sun	Elongation of the comet from the Sun	Angle of the trajectory's trace with the lines of sight of the comet's longitudes
26	24° 24′ ♉	14° 4′ B.	24° 24′ ♉	13° 59′ B.	6° 2′ ♍	*SCK* 138° 22′	*XKC* 100° 45′
27	23° 22′	17° 23′	23° 23′	17° 18′	7° 2′	136° 21′	101° 46′
28	22° 31′	20° 0′	22° 34′	20° 4′	8° 2′	134° 32′	102° 35′
29	21° 54′ ♉	22° 4′ B	21° 52′ ♉	22° 13′ B.	9° 2′ ♍	132° 50′	103° 17′
30	21° 21′	23° 48′	21° 21′	24° 0′	10° 3′	*SDL* 131° 18′	*XLD* 103° 48′
31	20° 58′	25° 20′	20° 54′	25° 26′	11° 3′	129° 51′	104° 15′
Jan. 1	20° 36′ ♉	26° 41′ B.	20° 34′ ♉	26° 41′ B.	12° 3′ ♍	128° 31′	104° 35′
2	20° 17′	27° 52′	20° 17′	27° 40′	13° 3′	*SEM* 127° 14′	*XME* 104° 52′
3	20° 0′	28° 57′	20° 8′	28° 28′	14° 3′	126° 5′	105° 1′
4	19° 50′ ♉	29° 56′ B.	20° 5′ ♉	29° 13′ B.	15° 4′ ♍	125° 1′	105° 4′
5	19° 44′	30° 46′	20° 2′	29° 47′	16° 4′	*SFN* 123° 58′	*XNF* 105° 7′
6	19° 43′	31° 30′	20° 2′	30° 12′	17° 4′	122° 58′	105° 7′
7	19° 45′ ♉	32° 5′ B.	20° 6′ ♉	30° 42′ B.	18° 4′ ♍	122° 2′	105° 3′
8	19° 53′	32° 38′	20° 12′	31° 2′	19° 5′	*SGO* 121° 7′	*XOG* 104° 57′

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Its full calculation, together with the diagram itself, we set out at length at p. 592 and following of this Book; but the table in which we have gathered the main points of the calculation we have put off to this place, as was done for the earlier comets. I wanted, however, to give it somewhat fuller than [those] of the other comets, and indeed for each single day of the appearance, with all those angles that belong to the calculation attached as well, as can be seen from the table itself set here.

[608] The table fills the upper two-thirds of the page under its title, in eight ruled columns, one row for each day from 14 December to 8 January; horizontal rules divide the rows into groups of three days, with a last group of two. The first row carries the column headings and the second the units (Decemb. over the days; Gr. M., degrees and minutes, over the other columns). Each zodiac sign and each A. (southern) or B. (northern) latitude is printed only in the first row of its group and holds for the rows below it. Columns 2 and 3 are blank on the page for 14–19 December. The italic capitals in columns 7 and 8 stand in one row of each group, as printed: the first row for the groups beginning 14, 17, 20, 23 and 26 December, the middle row for 29–31 December, 1–3 and 4–6 January, and the second row of 7–8 January. On 29 December column 3 prints B without a point. All headings, units, cells, signs and letters were read at zoom 3.

[Margin: AnTheoria Cometæ 1652 benè reſpondeat obſervationibus & phænomenis?] *Whether the theory of the comet of 1652 corresponds well to the observations and phenomena.* Nothing more remains, therefore, than for us to see briefly whether the commensuration of proportion [proportionis commenſus] of our theory also answers fittingly and properly to the observations and phenomena of this comet. Before we approach the matter itself, however, I think it should be pointed out that the comet shone for only a very short time, that the sky moreover seldom favoured us then, and that the comet was of itself of dim light, especially at the end, so that it could be observed exactly, as to longitudes and latitudes, on only some days; and that for this reason it was necessary to derive the comet's places by proportion for certain intermediate days, in which it was very easy to stray by one or two minutes. For that reason there is no cause for you to be so very scrupulous, on certain days, that is, to a single minute. In the others, however, though over the space of some days

Table Showing the Main Points of the Calculation [Tabula Calculi Capita exhibens.]

At midnight, as the day ends, New Style	Motion of the Earth from the intersection of the annual orbit and the trace of the trajectory	Angle of the trajectory's trace with the subtenses of the Earth's motion	Subtenses of the Earth's motion from that intersection	Distance of the perpendicular from the comet onto the trace of the trajectory, from the centre of the Earth	Distance of the same perpendicular from the intersection of the annual orbit and the trace of the trajectory	Height of the same perpendicular	True daily motion of the comet in the trajectory	Interval of the comet from the centre of the Earth
December	Deg. Min.	Deg. Min.	Semidiameters of the Earth	Semidiameters of the Earth	Semidiameters of the Earth	Semidiameters of the Earth	Semidiameters of the Earth	Semidiameters of the Earth
14	*XSQ* 5° 30′	*TXQ* 16° 6′	*XQ* 495	*QT* 165	*XT* 567	*Ta* 586	0	609
15	6° 30′	16° 36′	585	188	647	511	110	545
16	7° 30′	17° 6′	675	213	721	441	103	490
17	*XSP* 8° 30′	*RXP* 17° 36′	*XP* 765	*PR* 240	*XR* 792	*Rb* 373	98	443
18	9° 30′	18° 6′	854	270	860	308	94	409
19	10° 30′	18° 36′	944	303	926	246	91	390
20	*XSA* 11° 30′	*HXA* 19° 6′	*XA* 1034	*AH* 339	*XH* 990	*Hc* 185	88	386
21	12° 30′	19° 36′	1124	377	1052	126	86	398
22	13° 31′	20° 6′	1214	418	1112	69	83	424
23	*XSB* 14° 31′	*IXB* 20° 36′	*XB* 1303	*BI* 461	*XI* 1171	*Id* 13	81	461
24	15° 31′	21° 7′	1392	506	1229	42	80	508
25	16° 31′	21° 37′	1481	553	1286	96	79	566
26	*XSC* 17° 32′	*KXC* 22° 7′	*XC* 1571	*CK* 602	*XK* 1343	*Ke* 150	78	620

At midnight, as the day ends, New Style	Motion of the Earth from the intersection of the annual orbit and the trace of the trajectory	Angle of the trajectory's trace with the subtenses of the Earth's motion	Subtenses of the Earth's motion from that intersection	Distance of the perpendicular from the comet onto the trace of the trajectory, from the centre of the Earth	Distance of the same perpendicular from the intersection of the annual orbit and the trace of the trajectory	Height of the same perpendicular	True daily motion of the comet in the trajectory	Interval of the comet from the centre of the Earth
27	18° 32′	22° 37′	1660	652	1399	203	77	683
28	19° 32′	23° 7′	1749	704	1455	256	77	749
29	20° 32′	23° 37′	1838	757	1510	309	76	817
30	*XSD* 21° 33′	*LXD* 24° 7′	*XD* 1927	*DL* 811	*XL* 1565	*Lf* 361	75	888
31	22° 33′	24° 37′	2016	866	1619	412	74	959
Jan. 1	23° 33′	25° 7′	2105	923	1673	463	74	1033
2	*XSE* 24° 33′	*MXE* 25° 37′	*XE* 2193	*EM* 981	*XM* 1726	*Mg* 514	73	1108
3	25° 33′	26° 8′	2281	1040	1779	564	73	1183
4	26° 34′	26° 38′	2369	1100	1832	614	73	1260
5	*XSF* 27° 34′	*NXF* 27° 8′	*XF* 2457	*FN* 1161	*XN* 1884	*Nh* 664	72	1337
6	28° 34′	27° 38′	2545	1223	1936	713	72	1415
7	29° 34′	28° 8′	2633	1286	1988	763	72	1495
8	*XSG* 30° 35′	*OXG* 28° 38′	*XG* 2721	*GO* 1350	*XO* 2040	*Oi* 812	72	1575

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the comet was observed only, it is nevertheless properly deduced that it completed its course in an almost straight trajectory, and that by means of this all the phenomena can be preserved.

First, it is evident that the motion in longitude was direct, in the order of the signs, and indeed faster at the beginning than at the end, since the trajectory ran below the intersections [ſectiones] and the comet also headed almost toward the same quarter that the Earth was making for; for at first the lines of sight met at a more obtuse angle. [Margin: Phænomena omnia ex Schemate, & Theoriâ optimè ſalvantur.] *All the phenomena are saved excellently by the diagram and*

[609] The table fills the upper half of the page under its title, which repeats the title of the preceding page; it carries nine further columns for the same days, 14 December to 8 January, one row for each day, with horizontal rules dividing the rows into groups of three days and a last group of two, as on the preceding page. The first row carries the column headings and the second the units (Decem. over the days; Gr. M. and Grad. Min., degrees and minutes, over the second and third columns; semidiameters of the Earth, abbreviated Semid. Ter., Semid.Terr. or Semid.T., over the rest). The italic letters in columns 2–7 stand in one row of each group, as printed: the first row of the groups beginning 14, 17, 20, 23 and 26 December, the middle row of 29–31 December, 1–3 and 4–6 January, and the second row of 7–8 January; they are given as printed, capitals and small letters alike, in italics. On 14 December column 8 prints 0. All headings, units, cells and letters were read at zoom 3.

the theory. Next, it is also clearly seen that the apparent motion was extremely swift from the comet's first rising (especially on 20 December, when the comet was nearest the Earth, as the table shows), but afterwards became successively much slower — so much so, as the observations prove in every way, that it almost made a station; for the lines of sight were then approaching a parallel course, as is plain from the diagram at p. 592. As for the comet's showing a very short beard on 18 and 19 December, the reason is this: it was then not far from opposition to the Sun, a position in which no comet has a very conspicuous coma. Again, on 20 December a very large head and an extremely long tail were seen, since at that time the comet hung very close above us.

Kepler too observed the same thing, in the appendix to the *Histor. Comet.*, p. 95. [Margin: Quando Cometæ ſunt Terræ proximi, eo tempore caput, cauda & motus apparens diurnus apparent maxima.] *When comets are nearest the Earth, at that time the head, the tail and the apparent daily motion appear greatest.* "For (he says) in that part of their trajectory line in which comets come nearest the Earth — in that part, and at that moment of time — everything appears greatest: the head and the tail as well as the apparent daily motion, etc." Yet this very rule is sometimes subject to exception, as will be shown plainly by our Theorem 14, to be added below.

[Margin: Hic quoq; Cometa,circa exitum iter ſuum obliquavit.] *This comet too bent its path aside near its exit.* Moreover, it is gathered from the calculation and the table that, since the later latitudes deduced are smaller by a notable interval than those observed and assumed, it follows from this that this comet too, no less [than the others], bent its path aside from the straight track toward the ecliptic and the Sun, as all the earlier comets [did].

[Margin: Motus proprius in aliis Cometis creſcit, in aliis rursùs decreſcit.] *In some comets the proper motion grows; in others, on the other hand, it decreases.* Furthermore, the true proper motion in the trajectory did in fact also decrease from day to day, in a fitting proportion, as happened with almost all the earlier comets, excepting only those three comets, namely of 1607, 1531 and 1472, whose proper motion on the contrary grew successively. What the cause of this was will be shown in its proper place. The proper motion of this comet of 1652, however, and its decreasing proportion, were quite singular compared with all the others; yet the motion was fairly moderate, so that it was neither too swift nor slow. [Margin: Ab initio, motus propriusCometæ 1652, motum Terræ æquavit.] *At the beginning the proper motion of the comet of 1652 equalled the motion of the Earth.* From its first rising it almost matched the motion of the Earth (or, in the common way of speaking, of the Sun) in speed; but in the course of time it gradually slowed its pace. Others, on the contrary, were at certain times of their course much swifter than the Earth, or the Sun. But the genuine reason for this quickening or slackening is not so readily apparent to everyone, and it therefore deserves to be properly investigated; these matters, however, are reserved for a more convenient occasion, when this subject will be treated on purpose. The interval from the Earth, it is true, comes out of

the calculation somewhat greater around the beginning, and again toward the end a little smaller, than the observations themselves, and the parallaxes derived from them, determine it. But I think this happened for hardly any other reason than that the earlier and later observations were not obtained from the heavens with the same precision as the intermediate ones, for certain reasons already stated above. [Margin: Etiam ex hypotheſi non humilior Cometa evadit, quàm parallaxes eum definiunt.] *Even from the hypothesis the comet does not come out lower than the parallaxes determine it.* Whatever the case, it is nevertheless abundantly recognized from this hypothesis that the comet was in no way at all lower than our parallaxes place it, but rather, with respect to the Earth, not a little higher. [Margin: Omnes Cometas convenienter poſſe in Trajectoriâ conſervari.] *All comets can be suitably preserved in the trajectory.* With this we now at last conclude these nine comets, since, as I judge, we have fulfilled our promise abundantly and demonstrated with a full measure that all the comets brought onto the stage can be preserved fittingly and suitably by the trajectory — which cannot be done at all by circular paths [meatus circulares], especially by a single theory, and that a fixed one. On the other hand, I do not doubt in the least that, with God's favour, I would in the same way free very many other comets — indeed all of them — and every one of their phenomena from all inconsistencies and absurdities, if only their places were correctly known.

[Margin: Mirificis & planè admirandis Cometis demonſtratur, eos nullis aliis legibus, quàm Trajectoriæ eſſe obnoxios.] *It is demonstrated by marvellous and quite astonishing comets that they are subject to no other laws than those of the trajectory.* "But," you will say, "the calculation does not always answer to opinion." So it is, I readily grant; yet I nonetheless hold firmly to that view, and by no means haul back the rope. But so that you do not take my word without grounds that any comets whatever can indeed be bound by the laws of the trajectory, I shall now imagine certain astonishing comets, as to their motion and appearances; and although it has not been handed down to memory

Diagram. A full-page engraved plate, with no text on the page, carrying a single figure. A fan of straight lines runs down from the head of the plate and converges on one point at the top of a circle; the lines are lettered along their length. The upper half of the circle carries four zodiac signs. Below its horizontal diameter the circle is drawn as a chain of dotted points, numbered by fives and grouped by roman numerals, with zodiac signs beside them and letters at many of the points. A horizontal line crosses the figure along the diameter, marked with a row of small dots and numbered beneath; many straight lines run from the points of the circle and cross this line. Below the circle long lines run down to the foot of the plate, lettered and marked with zodiac signs at their ends. The labels engraved on the plate:

- Along the upper fan, from left to right: q, p, o, n, m, l, k, i, h; below them, near the centre of the fan: ♋.
- On three lines of the fan at the left, from top to bottom: r, s, t; on three at the right, from top to bottom: g, f, e.

- On the upper half of the circle: ♌ (upper left), ♊ (upper right), ♍ (lower left), ♉ (lower right).
- The left side of the circle, from top to bottom: a; 5, b; 10, c; d (just above the horizontal line); ♎ (on the line, to the left) and 15; 20, e; 25, f; I 30, g; h; ♏ and 15; i; II 30.
- The horizontal line: u (at its left end); *Trajectoria* (below it, at the left); the numbers beneath its points, from left to right: 1, 2, 3, 5, 10, 15, 20, 22, 25, 30, 35, 40; then a label of two engraved figures that are not read [?] (line F54); 15 and ♈ (at the right side of the circle); *Cometæ.* (below it, at the right); d (at its right end). Read together, the two words below the line say "Trajectory of the comet."
- The right side of the circle, from top to bottom: z, 30 IIV; ÿ; x; t; s; r; 30 IV; q; 15 and ♓; p; 30 V.
- The foot of the circle, from left to right: k; 15 and ♐; l; 30 above III; m, with 15 and ♑ below it; n, with 30 above IV below it; o; 15 and ♒.
- On the long lines below the circle: x (at the left) and c (at the right), on two crossing lines; a above ♎, at the foot of a vertical line at the left; ÿ, ♑ and b at the feet of three lines meeting below the centre; z above ♈, at the foot of a vertical line at the right.
- *Fig. BB.* (lower left): Fig. BB.
- *Autor ſculpsit.* (lower right): Engraved by the author.

that any of that kind ever shone forth, I am nevertheless fully settled in my own mind that it is not at all absurd that similar ones may appear at some time. And therefore, if any such were to appear, do not at once cast them down from the heavens into the air, however utterly disordered their course might seem; learn instead that even those which seem almost to reject all regularity and agreement of progression can none the less, with the help of the trajectory, have all their phenomena freed from all absurdities and abnormalities; whereas to accomplish this by circles would be exactly as if you wished to mix water with fire.

[Margin: Exemplum cujusdam Cometæ, qui ſeptem menſium ſpatio duodecim Signa & ampliùs trajiceret,motu apparenti perquàm irregulari.] *An example of a certain comet which in the space of seven months would cross twelve signs and more, with an extremely irregular apparent motion.* First, let us suppose a comet appearing for a space of seven months — which is by no means very absurd either, since very many have been seen for six months, and indeed another, namely in the year of Christ 975, on the testimony of Cedrenus and Lycosthenes, for 8 whole months. Let this comet, I say, always be direct, running through all twelve signs of the zodiac, and moreover going over half of that same zodiac [Signifer] a second time. So at the first time of its appearance it stands in Libra, and it not only returns to Libra again but moreover appears to advance as far as Aries — in such a way, namely, that it runs through Libra, Scorpio, Sagittarius, Capricorn, Aquarius and Pisces twice in an interval of seven months; and that with an apparent motion that is indeed

most irregular and anomalous, notwithstanding that its proper motion along its own track is supremely regular and orderly. [Margin: Poteſt Cometa diebus plùs minùs 25,novem; atq; diebus 50, ſedecim Signa Zodiaci pervolare.] *A comet can fly through nine signs of the zodiac in 25 days, more or less, and sixteen in 50 days.* In the first five days, completing Libra, Scorpio and Sagittarius, it will cover 60° in longitude; in the ten following days it will fly through 120°, that is, it will cross four whole signs as far as Aries; so that within 25 days from the first day of its shining it travels through 8 or 9 signs, from Libra as far as Gemini: with such speed must it move. In the course of time, however, it will proceed little by little at a slower pace, until, after about 100 days have passed, it has become quite stationary for some days near the beginning of Cancer. A little later it will again quicken its pace, and indeed to such a degree that at the last, when the seven months are at length completed, it is found within the space of 20 or 25 days — the final days, that is — to pass through nine signs once more. Such a comet, then, could pass through 16 whole signs of the zodiac in 50 days, although in the middle of its appearance it is so slow that over 160 days it scarcely crosses two asterisms of the zodiac. What, I ask, does it seem now? Would not a comet that displayed such a disordered and untimely, indeed interrupted, motion be extremely wonderful, and like a miscarriage? Certainly it would. Nevertheless, by means of our hypothesis it is easy to describe the phenomena of this kind properly, and likewise to demonstrate them, as is plain from the attached diagram.

[Margin: Mira cujusdam Cometæ phænomena, quæ abſurdiſſima ferè videntur, Schemate demonſtrantur.] *The wonderful phenomena of a certain comet, which seem almost utterly absurd, are demonstrated by a diagram.* In it let the circle be the ecliptic, or the annual orbit, showing the motion of the Earth at intervals of five days for seven months. Let the trajectory, or its trace, be somewhat smaller than the diameter of the great orb, so that it both begins and ends within the limits of the Earth's orb, as the straight line in the figure from number 2 to 43 shows. On this line, I say, the comet now moves; and its motion is marked off in the same way at intervals of five days, like the Earth's. In this case, however, there is no necessity for the trace to run to the centre of the great orb, near the Sun; rather, it can be removed from it by a quite notable distance, provided that in its course it travels almost parallel to the plane of the ecliptic. Indeed, it can also be inclined to that plane, and in various ways, cutting it, that is, at various angles — except that this would make the motion partly different, and would either lengthen or shorten the time of its duration; [Margin: Aliquando Cometæ heliacè occidunt & rursùs oriuntur.] *Sometimes comets set heliacally and rise again.* and it would then snatch the comet from sight for a time, around the middle days of its shining — if, that is, you place the trajectory too near the Sun, as will easily be plain to anyone who weighs and examines the matter somewhat more exactly. For the sake of better understanding, however, let us sketch the trace in the preceding diagram not far from the Sun, or the centre of the great orb. [Margin: Cometæ poſſident motum regularem, ut ut videantur in

ordinatisſimi inceſsûs.] *Comets possess a regular motion, however utterly disordered their course may seem.* Once the lines of sight are drawn from the Earth through the phenomenon, you will clearly see that everything really is so, and that the comet could not have completed its course otherwise than in the manner described — according to appearance, that is — although, as regards its true proper motion along the line of its path, it had and exercised one that was most regular and proportioned in the highest degree, in keeping with the structure of its body and the quality of its matter.

[Margin: Id quod graphicè declaratur.] *This is shown graphically.* For when the Earth is at *a*, namely in the sign ♏, the comet at number 1 would seem to stay in ♎; again, with the Earth at *b* and the comet at number 2, the phenomenon would then be in ♐; next, with the Earth at *c*, the comet at number 3 would be seen around the beginning of ♒. But with the Earth staying at *d*, the comet at number 4 would already be dwelling in ♈; and so, after 15 days had passed, it would be found by everyone to have completed six whole signs; and so on. Further, with the Earth placed at *m*, that is, in ♍, the comet would now be near the beginning of ♋, at number 22, and would indeed be advancing at an extremely slow pace. From then on, however, it would grow continually in apparent motion at the same rate at which it had earlier decreased, until — when the Earth had reached *t* at the beginning of the seventh month, and the comet number 39 — the comet would once more make such enormous leaps as at the beginning, with the greatest speed, namely in the last 20 days. [Margin: Cometam in recto tramite, motu proportionato incedere poſſe, & nihilo minùs 18 Sidera Signiferi quibusdam menſibus peragrare, clarè oſtenditur] *It is clearly shown that a comet can advance along a straight track with a proportioned motion, and none the less travel through 18 constellations of the zodiac in some months.* In sum, before the seventh month had elapsed, the comet would go round the whole heaven and half of it besides; that is, it would pass through 18 celestial signs — although its true proper motion along its straight track is supremely regular and proportioned, as we have drawn in the diagram. [Margin: Id quod Terrâ immobili ſuppoſitâ, atq; beneficio Eccentricorũ & Epicyclorum nullâ ratione fieri poterit.] *This will in no way be possible with the Earth supposed immobile, and by means of eccentrics and epicycles.* But let someone come forward from the opposing side, confident in spirit that he can free this comet and its phenomena from all inconsistencies and absurdities by orbs, or orbital lines, with the Earth standing still and the comet's own proper motion given as uniform — and that, indeed, in the sublunary air: to him, I promise, I will of my own accord hold out my hands and the grass [manus, herbamq́;] [in surrender]. But so far is anyone from ever accomplishing this very thing that the tortoise would sooner outrun the hare, and move mountains.

[Margin: Exemplum alterius cujusdam longè admirabilis Cometæ,qui meatu ſuo, etiam Cometam Regiomontani vincit.] *An example of another, exceedingly wonderful comet, which in its course surpasses even the comet of Regiomontanus.* But lest we rest content with this single and solitary marvellous comet, let

us imagine yet another, far more wonderful still — indeed more monstrous and marvellous, in its motion and its enormous leaps, than the very comet of Regiomontanus. In the space of only 48 days let it run through all twelve celestial signs, and that against their order. If one of this kind were ever noticed anywhere (as certainly can happen at some time) — good God! what panic terror, what horrible dread would seize the minds of many; with what zeal and effort, indeed, the whole Peripatetic sect would proclaim and harp on its course; with what joy it would leap up and exult; indeed, it would rejoice in triumphs over this comet,

Diagram. A full-page engraved plate, with no text on the page, carrying a single figure. Five long straight lines run down from the head of the plate, marked at their tops with zodiac positions. In the lower half a horizontal line crosses the figure, lettered at its points and labelled at its two ends; an arc numbered along its length rises above it, and further lines, among them a curve labelled as the great orb, run off below it to the left and right. From the points of the horizontal line long lines run down, with dotted lines between them, and converge on a single point at the foot of the figure; their lower ends are marked with zodiac positions. The labels engraved on the plate:

- On the long lines at the head of the plate: ♍ 25° and ♍ 22° (two lines at the left); ♎ 16°, ♎ 12° and ♎ 8° (three lines at the right, from left to right).
- On a line at the upper left: ♏ 34°.
- The horizontal line: ♈ (at its left end); *Trajectoria*, "trajectory" (below it, at the left); the points from left to right: p, o, n, m, l, k, i, h, g, f, e, d, c, b, a; ☌ (at its right end), with *Comet[?].* below it (line F42: the final letter carries a stroke above it whose nature is not settled, so the word is left as "comet" with the ending open).
- The arc above the horizontal line, from left to right: 61, 55, 49, 43, 37 (with ♎ below it, on the line through h), 31, 25, 19, 13.
- Below the horizontal line at the left: 18 ♈ (on a second line at the left end); 67 and 62 (where lines meet below n and m); 73; ♏ (on a line below 62); *Orbis* (between the two lines running up to the right from the lower left).
- Below the horizontal line at the right: 12 (on the line descending to the right beside c); 7 and ♍ (below b); A and 1 (at a point further down); *Die*, "day", above and *Magnus.* below a curve descending to the right — *Orbis … Magnus.*, "the great orb", read together with the label at the left; "1 Die", "day 1"; ♉ 8° (at the end of a line at the far right, engraved upside down).
- At the feet of the long lines converging below: 6°. ♓, 11. ♓, 17. ♓ (at the left); 28°. ♓ (at the centre); 9°. ♈, 14°. ♈, 16°. ♈ (at the right); S (at the point where the lines converge).
- A small engraved mark beside the foot of the line marked 17. ♓ that is not read [?] (line F53).

- *Fig. CC.* (lower left): Fig. CC.
- *Autor ſculpsit.* (lower right): Engraved by the author.

as if they had now at last obtained a most evident example, long since and greatly desired, by means of which (in their opinion, that is) it would be clearly and openly proved that there are comets wandering and erratic in the air. For the rest, however, this comet must advance rather slowly and sluggishly, in both longitude and latitude, during the first 12 days. [Margin: Spatio 24 horarum 5 Signa Zodiaci Cometa iſte tranat, & motu quidem regularisſimo.] *In the space of 24 hours this comet passes across 5 signs of the zodiac, and that with a most regular motion.* Between the 12th and the 13th day, however, it will cross in longitude — with a retrograde motion, that is — from Libra into Taurus, completing five signs in the space of 24 hours. As to latitude, likewise, it will vary in a wonderful way, by as much as 30, 40, indeed 50 degrees, in only a few days. Then, if it is supposed to survive longer, say up to the 61st day, it will advance at a very slow pace; again, from day 61 to day 62, it will pass from ♍ 18° to ♏ 14°, with its latitude changed beyond measure.

[Margin: Schemate & calculo oſtenditur, quo pacto id evenire posſit.] *It is shown by diagram and calculation how this can happen.* The hypothesis of this imagined comet, however, is so arranged that the trace of its trajectory cuts the Earth's annual orbit in two places, at an interval of about 48 days, with the Earth and the comet together not far from each point of intersection. And so that the matter may be all the clearer, I have not only duly drawn this imagined comet but also subjected it to calculation; the main points of the calculation, moreover, I have entered in the attached table, in which both the imagined longitude of the Sun and the imagined trajectory motion of the comet, together with its apparent longitude and latitude, can be seen. Besides the longitude of the Sun and the trajectory motion of the comet for every six days, it is supposed here that the trace of the trajectory cuts the Earth's annual orbit first at ♍ 6° and second at ♎ 24°, and likewise that, seen from the Earth, it stretches towards the tropical points. The trajectory itself, however, is imagined parallel to the plane of the annual orbit, at such a distance that on day 37 the latitude appears as 15 degrees north; so that, that is, the comet, although in conjunction with the Sun in longitude, may nevertheless be seen at night.

	Imagined longitude of the Sun	Imagined trajectory motion of the comet	Apparent longitude of the comet	Apparent northern latitude of the comet
Days	Deg. Min.	Semidiameters of the Earth	Deg. Min.	Deg. Min.
1	24° 30′ ♒	0	15° 32′ ♎	11° 54′
7	0° 25′ ♓	398	12° 11′	27° 5′
12	5° 21′		8° 26′	78° 10′
13	6° 20′ ♓	418	7° 55′ ♉	82° 37′
19	12° 15′	449	16° 25′ ♈	29° 4′
25	18° 10′	489	14° 0′	18° 53′

	Imagined longitude of the Sun	Imagined trajectory motion of the comet	Apparent longitude of the comet	Apparent northern latitude of the comet
31	24° 5′ ♓	544	8° 57′ ♈	15° 39′
37	0° 0′ ♈	614	27° 55′ ♓	15° 0′
43	5° 55′	613	16° 45′	15° 25′
49	11° 50′ ♈	543	11° 1′ ♓	18° 26′
55	17° 45′	488	6° 2′	28° 28′
61	23° 40′	448	17° 41′ ♍	71° 23′
62	24° 39′ ♈		14° 14′ ♏	74° 59′
67	29° 35′	418	25° 6′ ♏	27° 29′
73	5° 30′ ♉	398	22° 14′	12° 54′

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Consequently, then, with the Earth thus at A on the first day, and the line of sight drawn from there to the comet at *a*, the comet is in ♎; and it also remains there until the 12th day. [Margin: Quando Terra veſtigium trãſcendit Cometæ, tum mira deprehenduntur phænomena.] *When the Earth crosses the trace of the comet, then wonderful phenomena are detected.* For since between the 12th and 13th day the Earth passes over the trace, and the comet at the same time glides past the Earth at *d*, very close to it, the phenomenon certainly cannot remain in ♎ any longer; instead, by an apparent retrograde motion, it will appear already to have traversed five signs of the zodiac in that space of 24 hours, and to be in ♉. This happens when the Earth goes from one side of the trajectory to the other, as the lines of sight clearly show. [Margin: Terrâ &Cometâ ſimul eandem plagam versùs incedentibus,motus Cometæ retardari videtur.] *When the Earth and the comet advance together towards the same region, the comet's motion seems to be slowed.* After this, however, the comet will suddenly become slow, as can be seen at *e*, namely *f*, *g*, *h*, etc.: since the Earth, together with the comet, performs an almost equal motion towards the same region. But with the Earth placed in turn at *m*, or No. 61, and the comet at *n*, at places so near to each other, that excessive speed and that marvellous leaping arise once again: from day 61 to day 62 the comet crosses over from ♍ 18° to ♏ 14°, and after that, near *o* and *p*, it again moves remarkably slowly.

[Margin: Quomodo Cometa motu regulari vero incedat, & nihilo ſeciùs tortuoſum conficere iter, & enormiter ſaltare appareat.] *How a comet may advance with a regular true motion, and nevertheless appear to make a twisting path and to leap enormously.*

[610] The table stands without a title at the left of the page, beside the paragraph that introduces it, in five ruled columns. The first row carries the column headings, its first cell blank; the second row carries Days over the first column and the units over the others (Gr.M., Gr. M. and Gr. Mi., degrees and minutes; Sem. T., semidiameters of the Earth). The rows run at six-day steps from day 1 to day 73, with the extra rows for days 12, 13, 61 and 62, and short rules divide them into groups of three. A sign of the zodiac is printed only where shown and holds for the rows below it. The column of the comet's trajectory motion is blank for days 12 and 62.

The result is that such a comet, beginning on day 13 and continuing to day 61 — that is, over a span of 48 days — would appear to travel through the whole zodiac, and at the same time, with respect to the fixed stars, to perform an ominous and utterly abortive or twisting motion, as if it were raised now and lowered now in the slightest moment, without law or order, as the apparent latitudes in the preceding table show to the eye. For at the start of its motion it shows a north latitude of only 12°; on day 13, a little later, it will already have a latitude of 83 degrees; from then on, however, its latitudes will suddenly increase[611], up to day 37, where it will be seen almost stationary. Then, after a very short interval of time, namely on the sixty-second day, it will again make up 75 degrees in a sudden leap; and finally, in the last eleven days, it will once more show exactly the same latitude, north 12 degrees, that it showed at its first entry.

[Margin: Peripateticorum judicio poteſt alius Cometa eſſe vagabundus, & erraticus,cùm tamen ſit reverà regulariſſimus.] *By the judgement of the Peripatetics another comet can be wandering and erratic, though in reality it is most regular.*

Just as this would be no common phenomenon, and almost contrary to the whole of nature, so by the reckoning of all the Aristotelians, and of many others too who grasp these matters less well, it would be judged — of pressing necessity, and without any doubt — to be subject to some true proper motion, and a most irregular one. And yet it is clear from the preceding table that its true proper motion can be entirely regular, compounded in a fixed proportion to the impulse, the course and the constitution of the body.

[Margin: Motus iſtius Cometæ proprius, quantus ſit diurnus.] *How great the daily proper motion of this comet is.*

This happens, indeed, in such a way that at the outset this motion is roughly 60 or 70 semidiameters of the Earth, the speed then growing each day in due measure until the comet comes very near the Sun (as happened with all the comets above), when its proper motion in the trajectory grows to 100 semidiameters of the Earth. After that it will be seen to decrease again in the same proportion, until on any given day it covers only 60°[612] semidiameters of the Earth. At this point I would also have you note that another comet could be constructed on almost the same gait which would go round the whole zodiac in a much shorter interval still — namely on the condition that its trajectory is set to subtend a shorter part of the annual orbit; and then those phenomena would be accomplished far sooner. By these signs, clearer than any light, it is proved again and again that even such comets, never sufficiently to be wondered at — more remarkable in many ways than Regiomontanus's hairy star, both in speed and in their wondrous advances and reversals — can be neatly and fittingly explained and demonstrated by our theory.

[611] the table on the preceding page has the latitude falling from 82° 37′ on day 13 to 15° 0′ on day 37

[612] the page prints a degree mark after this 60

[Margin: Alius Cometa fingi poteſt, qui breviori temporis ſpatio totum Zodiacum percurrat.] *Another comet can be imagined that runs through the whole zodiac in a shorter space of time.*

Lastly, I will devise yet another comet, which in its apparent motion, as it were disordered and irregular, would far surpass the former one, and would hang in the aether for a whole year (like the plainly portentous one seen above Jerusalem in the year 70 after the birth of Christ). This comet, I say, would cross in the axis of the ecliptic, or in some line parallel to it, within the annual orbit of the Earth, ascending towards the pole or descending from there.

[Margin: Cometam dari poſſe integro anno conſpicuum,atq́; ſpirali motu integrum ſigniferum trajicientem.] *That a comet can be given which is visible for a whole year and crosses the whole zodiac with a spiral motion.*

And so, over the space of a year, it will appear to pass through the whole zodiac in longitude with a twisting and spiral motion, its latitudes meanwhile growing proportionally day by day. Finally, if it could last long enough to reach such a distance from the Earth that the annual orbit vanished entirely relative to its distance, then, I say, it would become wholly stationary, and perpetually

Diagram. A full-page engraved plate, with no text on the page, carrying a single figure in two parts, one above the other. In the upper part a dotted curve, open at the bottom, is marked with zodiac signs, and below it a dotted arc runs out to the far right, also marked with signs. Straight lines run down from the marked points of both dotted curves, cross one another in the middle of the figure, and reach a solid ellipse, seen obliquely, at the foot of the figure, which is marked round its edge with the twelve signs and lettered inside. A long vertical line runs down the middle of the figure from the top of the upper part into the ellipse, with five small unlettered points on it where the lines cross. The labels engraved on the plate:

- The upper dotted curve, from its left side over the top to the right: ♈, ♉, ♊, ♋ (at the top), ♌, ♍; and ♎ inside the curve below ♍, where the dotted line turns down to the left.
- The dotted arc below it, from left to right: ♓, ♒, ♑, ♐, ♏ (at its right end).
- The solid ellipse at the foot: ♈ (left end); ♓, ♒, ♑, ♐, ♏ (along the far side, from left to right); ♎ (right end); ♍, ♌, ♋, ♊, ♉ (along the near side, from right to left).
- S (inside the ellipse, beside the vertical line).
- *Fig. DD.* (lower left): Fig. DD.
- *Autor ſculpsit.* (lower right): Engraved by the author.

also be found fixed in the same place of the heavens, like some fixed star, as regards its apparent motion; except that it would be carried round the pole by the diurnal motion alone, in the space of 24 hours; although in reality, with a continuous motion, it would move away from the Sun and the Earth and rise:

as is sufficiently clear both from the table and from the diagram, without any further explanation.

[Margin: Quâ ratione Cometa videri posſit ſemper qua motum proprium immotus, & non niſi motu diurno moveri.] *How a comet can seem always motionless as to its proper motion, and be moved only by the diurnal motion.*

The apparent motion of an imagined comet which is supposed to ascend straight from the Sun towards the pole of the ecliptic [Motus apparens Cometæ alicujus ficti, qui rectà à Sole aſcendere ponitur versùs Polum Eclipticæ.]

Days	Apparent longitude	North latitude	Days	Apparent longitude	North latitude
	Deg. Sign	Deg. Min.		Deg. Sign	Deg. Min.
1	0° ♏	15° 10′	181	27° ♈	44° 45′
6	5°	16° 10′	186	2° ♉	45° 20′
11	10°	17° 15′	191	7°	45° 50′
16	15° ♏	18° 15′	196	12° ♉	46° 25′
21	20°	19° 20′	201	17°	46° 55′
26	25°	20° 20′	206	22°	47° 25′
31	0° ♐	21° 20′	211	27° ♉	48° 0′
36	4°	22° 20′	216	2° ♊	48° 30′
41	9°	23° 15′	221	7°	49° 0′
46	14° ♐	24° 15′	226	12° ♊	49° 30′
51	19°	25° 10′	231	17°	50° 0′
56	24°	26° 5′	236	22°	50° 25′
61	29° ♐	27° 0′	241	27° ♊	50° 55′
66	4° ♑	27° 55′	246	1° ♋	51° 20′
71	9°	28° 50′	251	6°	51° 45′
76	14° ♑	29° 45′	256	11° ♋	52° 15′
81	19°	30° 35′	261	16°	52° 40′
86	24°	31° 25′	266	21°	53° 5′
91	29° ♑	32° 15′	271	26° ♋	53° 30′
96	4° ♒	33° 0′	276	1° ♌	53° 50′
101	9°	33° 50′	281	6°	54° 15′
106	14° ♒	34° 35′	286	11° ♌	54° 40′
111	18°	35° 25′	291	16°	55° 0′
116	23°	36° 10′	296	21°	55° 25′
121	28° ♒	36° 50′	301	26° ♌	55° 45′
126	3° ♓	37° 35′	306	1° ♍	56° 10′
131	8°	38° 20′	311	5°	56° 30′
136	13° ♓	39° 0′	316	10° ♍	56° 50′
141	18°	39° 40′	321	15°	57° 10′
146	23°	40° 20′	326	20°	57° 30′
151	28° ♓	41° 0′	331	25° ♍	57° 50′
156	3° ♈	41° 40′	336	0° ♎	58° 10′
161	8°	42° 20′	341	5°	58° 30′
166	13° ♈	42° 55′	346	10° ♎	58° 45′
171	18°	43° 35′	351	15°	59° 5′
176	22°	44° 10′	356	20°	59° 25′

Days	Apparent longitude	North latitude	Days	Apparent longitude	North latitude
			361	25°	59° 40′

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But I will not dwell on these matters any longer (although a great many more things could still be brought forward, if I were bent on length), since I seem to myself to have dealt with this subject quite abundantly — above all by setting out those nine genuine and duly observed comets — and also to have demonstrated most fully, as was my purpose, that those comets, and indeed all the others, fittingly run their course in a trajectory, and that their phenomena can be preserved universally and most correctly.

[Margin: Abundè igitur patet, quævis Cometarum phænomena feliciter posſe hâ[[o/c]] noſtrâ Trajectoriâ ſalvari.] *It is therefore abundantly clear that any phenomena of comets whatever can be successfully saved by this [?] trajectory of ours.*

[Margin: Antequam rationes phyſicæ de motu rectilineo perquirantur, neceſſe eſt, ut Theoremata nonnulla præmittantur.] *Before the physical reasons for the rectilinear motion are inquired into, some theorems must be set out in advance.*

Before we inquire into the natural and physical reasons — namely, where this nearly rectilinear motion takes its origin, and what else seems to bear on the matter — let us set out in advance certain theorems, drawn partly from the natural propensity of this trajectory and partly from those earlier comets. I do not doubt that they will bring much light and certainty to everything that has been brought forward in this book on trajectory motion, and to everything that is to be brought forward hereafter. Kepler, indeed, that man of most profound genius, has already made mention of some of these theorems in his History of Comets; but they are scattered there piecemeal, some are obscure and long-winded, and some are not even universal, as the said author did indeed persuade himself [they were]. Accordingly we have chosen only the more certain ones, and have condensed and clarified them, adding certain new ones first discovered in connection with the comets above. Above all, however, we have taken care that the theorems should be directed to those 9 preceding comets and at the same time confirmed by their examples; and that others, more difficult and more obscure, should, where there was need, be illustrated and demonstrated by diagrams.

[613] The table stands at the left of the page, beside the paragraphs that follow, under a title running across its full width. It is set in two halves side by side, each with its own three ruled columns, separated by a narrow blank channel: the first three columns here are the left half (days 1 to 176), the last three the right half (days 181 to 361); the right half runs one row lower, so the last row has nothing in its left half. The second row carries the units: Gr. S., degrees and signs, over the longitudes, and Gr.M., degrees and minutes, over the latitudes; the days columns carry none. Short rules divide the rows into groups of three. A sign of the zodiac is printed only where shown and holds for the rows below it.

From these we shall understand correctly and thoroughly how matters stand with the trajectory and its trace, with the lines of sight and the intersections of the lines of sight, and also with its exceedingly wonderful motion.

Theorems on the Motion and Trajection of Comets [Theoremata de motu & Trajectione Cometarum.]

[Margin: Vnde immobile corpus etiam moveri videatur.] *Why a motionless body may also seem to move.*

1. If a body does not really change its place but rests motionless, it would nevertheless appear to move in longitude in the ecliptic within any two days, because of the annual motion of the Earth: directly, indeed, in the hemisphere of the Sun, and retrograde in the opposite one. The exceptions are if perhaps either the distance between that body and the Earth is immense, and such that the Earth's motion bears no sensible ratio to it; or if, at the place midway between those two days, it appeared in quadrature with the Sun, so that the straight line drawn through both places of the Earth also passes through the body itself. For example, the body *c*, in diagram I of the attached figure, whether it advances along the straight line *a c* or rests at *c*, would appear to have the same longitude with the Earth at either place, *a* and *b*.

[Margin: Corpus ſecundùm longitudinem quieſcens, reverà movetur.] *A body at rest in longitude is in reality moving.*

2. If a body seems to change its longitude in the ecliptic not at all within any two days, it must in reality be advancing. For it seems stationary when the lines of sight of the two days, *a d* and *b e* (namely in diagram II), are parallel, and so seem to fall on the same point among the fixed stars. These, however, cannot be parallel unless both the phenomenon *c* and the Earth *a* have really changed place.

[Margin: Quando phænomenum videatur ſtationarium.] *When a phenomenon seems stationary.*

If, however, its distance from the Earth is immense, it can both appear stationary to us and be really motionless, like the fixed stars. Likewise, it is clear from the preceding theorem that, if it is placed near quadrature with the Sun, it can also, while really motionless, seem stationary to us as well.

[Margin: Quando lineæ viſoriæ ſe ſe interſecent; rursùs quando divaricentur.] *When the lines of sight intersect one another; and again, when they diverge.*

3. If a body in the hemisphere of the Sun seems to move directly in longitude in the ecliptic, the lines of sight of longitude of the two days intersect one another on the side towards the body, either above or below it, as can be seen in the comets of the years 1531, 1532, 1577, 1590 and 1607. But if the same body in the hemisphere of the Sun is retrograde in longitude, the lines of sight of the two days diverge towards the body itself, converging towards the opposite region of the Earth. Proof of this is the comet of the year 1472, and of 1618. If the phenomenon is seen in the hemisphere

opposite the Sun, the contrary of these occurs. Thus, namely, the lines of sight of the comet of the year 1585, which was direct near opposition to the Sun, diverge towards the comet; but the lines of sight of the comet of the year 1652, which was retrograde, intersect above the trajectory.

[Margin: Angulus ad ſectionem viſoriarum, æquatur motui longitudinis.]
The angle at the intersection of the lines of sight equals the motion in longitude.

4. The lines of sight of longitude of two days, wherever they intersect, make an angle equal to the comet's motion in longitude within those two days. But if the comet is stationary, the lines of sight are parallel. The latter is evident from the second theorem; the former from diagram III. For if from the later place of the Earth, *b*, the straight line *b f* is drawn parallel to the line of sight *a e* of the earlier day, this same [line] will show the place of the comet in the ecliptic on the earlier day; and the angle *d b f*, which it makes with the later line of sight *b d*, will determine the motion in longitude covered in the two days; and to that angle *d b f* the angle at the intersection of the lines of sight, *a c b*, is equal.
5. Given the apparent motion of the comet in longitude, *a c b*, in the same diagram III, and the angle between the comet and the Sun at the Earth, *s a e* (that is, the elongation of the comet from the Sun, or conversely of the Sun from the comet), there is also given the distance of the inter-

Diagram. A full-page engraved plate, with no text on the page, carrying eight circles numbered I to VIII, set in three rows: I, II and III across the top; IV and V below I and II, with VI below III at the right; VII and VIII at the foot. Each circle is lettered on and about its edge, with straight lines drawn from points on the circle out to lettered points beyond it, several lines being marked as the trajectory; the centre of each circle from II to VIII is marked S, and that of circle I *Sol.* Some of the lines are dotted. The labels engraved on the plate:

- Circle I: *I* (in the circle); *Sol.* (below it): the Sun; *a* (on the circle at the left) and *b* (on the circle at the top), on a straight line that runs up to *c*, with *Trajectoria.* written along it: Trajectory.
- Circle II: *II* (in the circle) and *S* (below it); *a* and *b* (on the top of the circle), from which two parallel lines rise to *d* and to *c* (the latter faint); a horizontal line with *Trajectoria.* written above it: Trajectory; *c* and *f* where the two parallel lines cross it.
- Circle III: *III* (in the circle), *S* (at its centre, where the lines meet) and *c* (to its right); on the circle at the upper left *a* and *b*, with lines rising to *d*, *e* and *f* (on a dotted line), crossing at *c*, and a line with *Trajectoria* written along it: Trajectory; on the circle at the top *a* and *b*, with lines rising to *e*, *f* (dotted) and *d*.
- Between circles III and VI, on three lines rising from the top of circle VI: *d*, *c* and *e*.
- Circle IV: *IV* (in the circle) and *S* (below it); *c*, *e*, *g* and *A* (on the right edge, from the top down); *B* (at the left), at the end of a line with *Trajectoria* written along it: Trajectory; *h*, *f* and *d* (on the lines at its right end).

- Circle V: *V* (in the circle) and *S* (below it); *A* (at the upper right); *g*, *e* and *c* (on the edge at the lower left), from which three lines run to the upper right, crossing at *d*, *f* and *h* a line from *B* (at the bottom) with *Traject.* written along it: Traject[ory].
- Circle VI: *VI* (in the circle) and *S* (below it); *a*, *f* and *b* (on the top of the circle); a vertical line from *f* with *Trajectoria.* written along it: Trajectory.
- Circle VII: *VII* (in the circle), *S* (at its centre, joined by lines to *e* and *a*); *k*, *i*, *h*, *g*, *f* and *c* (on the lines descending past the left edge, from the top down), *b* (on the circle below them), *e* (on the circle at the upper left), *d* (inside the circle below *e*), *a* (on the circle at the bottom); a line with *Trajectoria.* written along it: Trajectory.
- Circle VIII: *VIII* (in the circle) and *S* (below it); a line with *Trajectoria.* written along it: Trajectory, ending at *d* on the circle, with *e* to its right and *c* on the circle at the left; *b* (on the circle at the left) and *a* (at the lower left); *f*, *g*, *h* [?], *i* and *k* (on the lines running down to the lower left, from the top down).
- *Fig. EE.* (lower left): Fig. EE.
- *Autor ſculpsit.* (lower right): Engraved by the author.

section *c* from either place of the Earth, namely *a c* or *b c*. For if the complement of half the Earth's motion covered in those same days, *s a b*, is subtracted from or added to the angle between the comet and the Sun, *s a e*, as the case requires, the angle between the comet's line of sight and the subtense of the Earth's motion, *b a c*, becomes known. Hence in the oblique-angled triangle *b a c*, since one side, *a b*, and two angles, *b a c* and *a c b*, are known, the remaining sides *a c* and *b c* are also found.

[Margin: De motu apparente longitudinis & angulo inter Cometam & Solem ad Terram.] *On the apparent motion in longitude, and on the angle between the comet and the Sun at the Earth.*

[Margin: Veſtigium longitudinis, nonnunquam idem eſt cum viſoriâ longitudinis.] *The trace of longitude is sometimes the same as the line of sight of longitude.*

6. If the trajectory plane of the comet, or the trace of the trajectory on the plane of the ecliptic, cuts the Earth's annual orbit somewhere, that trace will necessarily be the same as the comet's line of sight of longitude at the moment when the Earth falls into that intersection. This is evident in all the comets whose theories have been established, except the one seen in the year 1585.

[Margin: Ex ſectionibus viſoriarum cognoſcitur,quàm plagam versùs, ratione motûs Terræ, Trajectio fiat.] *From the intersections of the lines of sight it is known in which direction, relative to the Earth's motion, the trajection takes place.*

7. If the comet is above the intersections of the lines of sight of longitude, its trajection is in the direction contrary to the Earth's motion. Compare the comets of the years 1541, 1577 and 1590. But if the comet is below the intersections, or if the lines of sight diverge towards the comet, it

crosses in the same direction as the Earth. See the comets of the years 1585 and 1652. It should be noted here, however, that if the trajectory trace *A B* (in diagram IV) cuts the annual orbit, then, in Kepler's view, the motion in one segment tends in the direction contrary to the motion in the other segment. Hence the comet, crossing from *d* through *f* to *h*, follows the Earth's motion in the smaller segment (in diagram IV, that is), and so is contrary to the Earth's motion in the larger segment; although, while the Earth goes from *c* through *e* to *g*, if you look towards the Sun *s*, the motion *c e g* is not contrary to the motion *d f h*. Let the theory of the comet of the year 1532 be examined, around the beginning of its appearance.

[Margin: Quando motus phænomeni contrarius ſit motui Terræ; e contra quando motum illius ſequatur.] *When the motion of the phenomenon is contrary to the Earth's motion; and conversely, when it follows the Earth's motion.*

In diagram V the motion *d f h* is contrary to the Earth's motion through the smaller segment, and so follows the Earth's motion through the larger segment; although with respect to the Sun the Earth's motion *c e g* seems to be contrary to the comet's motion. This happened with the comet of the year 1607. But what is to be decided about the comet of the year 1618? As long as it moves within the Earth's annual orbit, with the lines of sight diverging, it follows the direction of the Earth's motion through the smaller segment; and yet it seems to follow that direction also after it has left the bounds of that orbit and is placed above the intersections of the lines of sight. What about the comet of the year 1472? It went contrary to the Earth's motion through the smaller segment no less around its beginning than afterwards, however much it was below the intersections of the lines of sight at the start. There seems, therefore, to be no room for Kepler's theorem IV, except where the Earth moves almost parallel to the comet, or not much otherwise.

[Margin: De diſtantiâ perpendiculi ex Cometâ à centro Terræ.] *On the distance of the perpendicular from the comet from the centre of the Earth.*

8. When within two days the Earth falls into the comet's trajectory trace, the perpendicular from the comet at some moment midway within those days is as far from the centre of the Earth as is the intersection of the two lines of sight that belong to those days. Let *a* be the earlier position of the Earth and *d* that of the comet, in diagram VI; *b* the later position of the Earth and *e* that of the comet; *d e* the daily portion of the trajectory trace; *c* the point of intersection of the lines of sight. It is evident that the perpendicular from the comet between *d* and *e* can be as far from the Earth *f* as *c* is from *b* itself or from *a*.

[Margin: Quando Terra veſtigium transgreditur, ſitus Cometæ & ſectionum permutantur.] *When the Earth crosses the trace, the positions of the comet and of the intersections are interchanged.*

9. When the Earth passes the trajectory trace, the positions of the comet and of the intersections are interchanged: that is, if it was at first above

the intersections, after the Earth's passage it will be below them; and conversely. See the comets of the years 1607 and 1618. In the one that Regiomontanus observed in the year 1472, the lines of sight diverge towards the comet immediately after the Earth's passage, whereas it had previously been below the intersections.

[Margin: Quo loco Cometa ſit directus, ſtationarius & retrogradus, cùm veſtigium tangit Orbem annuum.] *In which place the comet is direct, stationary and retrograde, when the trace touches the annual orbit.*

10. If the comet's trace touches the annual orbit at *c* (in diagram VII), and the comet moves away from that point of contact towards *i*, while the Earth meanwhile follows the comet and approaches that point of contact *c*, the comet is in the hemisphere of the Sun above the intersections, and so direct, for as long as it takes the Earth to reach that point of contact *c*. There the comet becomes stationary in quadrature with the Sun; and after the Earth has passed the point of contact *c*, it is plainly retrograde, placed in the hemisphere of the Sun below the intersections of the lines of sight. See diagram VII, where the five places of the Earth, *a b c d e*, are matched in the same order by as many positions of the comet, *f g h i k*.
11. But if the comet, on a trace that touches the annual orbit, moves away from the point of contact *c* (namely in diagram VIII), while the Earth meanwhile approaches that point with a contrary motion, the comet is retrograde, and in the hemisphere opposite the Sun above the intersections of the lines of sight, for as long as it takes the Earth to reach the point of contact *c*. There, however, the comet seems to change its apparent course in quadrature with the Sun, and to move direct below the intersections of the lines of sight, in the hemisphere of the Sun.

[Margin: Quando ſectiones viſoriæ magis magisq́; à Terrâ elongantur.] *When the intersections of the lines of sight move farther and farther from the Earth.*

12. If the daily motion in longitude of a comet that is direct in the hemisphere of the Sun, or retrograde in the opposite one, decreases, the intersections of the lines of sight continually rise to a greater distance from the Earth, until the comet becomes stationary and the lines of sight become parallel. See the comets of the years 1577, 1618 and 1652.

[Margin: Nonnunquam Cometa circa oppoſitionem Solis retrogradus ſit.] *That a comet is sometimes retrograde near opposition to the Sun.*

13. If the comet's trace moves directly away from the Sun, the comet is retrograde near opposition to the Sun; and even if the daily portions of the trajection are uniform, or decrease, the apparent retrograde motion in longitude continually diminishes until it reaches a station, as is clear from diagram IX.

[Margin: Motus apparens diurnus, non ſemper, ubi proximus Terræ, maximus eſt.] *The apparent daily motion is not always greatest where [the comet is] nearest the Earth.*

14. If the comet's trajection were uniform, its apparent daily motion would appear greatest where it was nearest the Earth; but if the daily portions of the trajection increase or decrease, it can happen that the apparent motion is greatest somewhere other than where it comes nearest the Earth.

[Margin: Pleruńq; Cometa propior eſt Terrâ, ubi viſoriæ adTrajectoriam ſunt obliquæ.] *The comet is usually nearer the Earth where the lines of sight are oblique to the trajectory.*

15. If the Earth did not move, the comet would be nearest to it where the line of sight fell perpendicular on the trajectory. But since the Earth goes round in the great orb, the comet usually comes closer to the Earth where the lines of sight are oblique to the trajectory. Thus, in 1652, the line of sight of longitude of December 23 is indeed more nearly at right angles to the trajectory trace, but on the day December 14 Q. T. is shorter. See the diagram on page 592.

[Margin: Vbinam Trajectio ſit celerrima, & quo loco maximè variet.] *Where the trajection is fastest, and in which place it varies most.*

16. The nearer the comet comes to the Sun in its trajectory, the more it seems to intensify its course, so much so that the trajection is fastest when the straight line drawn from the Sun to the comet is perpendicular to the trajectory itself. Conversely, if the comet moves away from the Sun, it slackens its trajectory motion. In either case the intensification or slackening varies the more, the nearer the comet comes to the perpendicular from the Sun; so that the trajection is never uniform, but the daily portions of the same trajection perpetually increase or decrease. This is attested by all the comets for which observations survive from which theories could be constructed. And although the one that Appianus observed in the year 1532 may seem to stand in the way, not even that comet, if properly considered, will reject this law. For even if the trace of the trajectory still approaches nearer to the Sun, the trajectory itself, oblique to the plane of the ecliptic, either is at right angles to the Sun around the beginning of the comet's appearance, or has already moved away from the perpendicular.

[Margin: Cometæ à recto tramite nonnihil ad Solem deflectunt.] *Comets deflect somewhat from a straight path towards the Sun.*

17. In its trajection the comet seems to stray somewhat from the perfection of a straight line, and to bend its course towards the Sun. This is inferred from all those comets that were accurately observed over several days, but above all from the comet of the year 1577 and of 1652. For here the latitudes at the beginning and at the end are made somewhat smaller by the hypothesis, and in the middle larger, than the observations show them. But the observations agree with the hypothesis if the trajectory is curved a little towards the Sun. The other comets leave this uncertain, since they were observed either on fewer days than would suffice here, or less accurately.

[Margin: Quando Cometæ admirandæ velocitatis, ſimul flexuoſum iter peragere appareant.] *When comets appear to be of wonderful speed, and at the same time to travel a winding course.*

18. If ever the Earth and the comet, with respect to its trace, arrive at almost the same time at the mutual intersection of the annual orbit and the trace, and the height of the perpendicular from the comet onto the plane of the ecliptic is not very great, the comet necessarily appears to be of wonderful speed, such as was the one that Regiomontanus observed. Indeed, if the comet's distance from the Earth at that same time, when the comet reaches the intersection of the trace, is much less than the Moon's distance, then the comet appears to move along a winding and also spiral path until it passes beyond the Moon; there, in turn, it proceeds by a straight way, just as at the beginning.

[Margin: Quâ ratione per integrum annum Cometa conſpici poſſit.] *In what way a comet could be seen throughout a whole year.*

19. If the comet were to cross along the axis of the ecliptic, or along some [line] parallel to it within the Earth's annual orbit, ascending towards the pole and descending again from there, it would seem to traverse the whole ecliptic in longitude within the space of a year, but with a twisting and shell-shaped motion, as is clearly demonstrated in diagram D d on page 636.

[Margin: Quomodo ſeptem menſium ſpatio totū Zodiacum Cometa permeare poſſit.] *How a comet could traverse the whole zodiac in the space of seven months.*

20. If the trace of some comet were contained within the bounds of the annual orbit, and yet were not much smaller than the diameter of that orbit, such a comet would pass through the entire ecliptic in its motion in longitude within the space of seven months; this is clear from diagram B b, inserted at page 632.

[Margin: Vnde Cometa versùs Polum aſcendere, rursùs deſcendere ad Eclipticam videatur.] *Why a comet seems to ascend towards the pole, and to descend again to the ecliptic.*

21. If the comet's trace is supposed to cut the Earth's annual orbit twice, with the Earth and the comet together being not far from either point of intersection, the same comet could be seen twice with wonderful speed. And even if the trajectory itself is placed always on one side of the plane of the ecliptic, so that the comet has a latitude either always northern, or southern, such a comet would seem to ascend from the ecliptic towards the poles, and from there to descend again to the ecliptic, and from there to be carried up again to the pole, and to be pressed down once more to the ecliptic. An example of this is diagram C c, set down on page 634.

[Margin: Kepleri Theoremata nō ſunt univerſalia, nec omnem rem acu tangunt.] *Kepler's theorems are not universal, nor do they hit the mark in every matter.*

Other theorems besides these could indeed still be constructed and set down here, but I think it entirely superfluous, since the chief sum of the matter already lies hidden in those presented. The remaining ones that Kepler added are either by no means relevant to this subject, and rather trivial, such as theorems VI, XVII and XXIII; or to be rejected outright, such as theorems XIV and XV, because only for a uniform trajection are they va- lid, such as Kepler seems to have assumed; whereas we have been taught by the examples of all the comets that the motion of the trajection perpetually increases or decreases.

Moreover, theorems XIX and XXII are also of no use: the former because the comet's distance can exceed that chord by a very great amount; the latter for this reason, that even if the comet is less than a quadrant from the Sun in longitude, the perpendicular from the comet can nevertheless fall outside the bounds of the Earth's annual orbit in the ecliptic.

[Margin: Sive ſupra,ſive infra ſectiones ſit Cometa, poteſt tamen eſſe retrogradus; contra Kepleri opinionem.] *Whether the comet is above or below the intersections, it can still be retrograde; contrary to Kepler's opinion.*

The following theorems of the same author, such as, first, theorem XI, are not of perpetual truth. For in that theorem he teaches that if some phenomenon is above the intersections of the lines of sight, it cannot become stationary or direct from retrograde, or the reverse, unless the Earth in its orb has crossed the trajectory trace; and indeed none of the observed comets contradicts this. But it is clear from the attached diagram X that if, with the Earth placed at A, the comet is at H, and while the Earth is carried forward from A through B, C, D the comet proceeds along its trace towards I, K, L, etc., then at first the comet will be above the intersections of the lines of sight and retrograde; after that it becomes stationary, and while the Earth is between D and E it is plainly direct and placed below the intersections of the lines of sight; after that, as the Earth advances to F and G, it again becomes retrograde and moves above the intersections of the lines of sight.

[Margin: Licet veſtigiumTrajectoriæ non ſecet Orbem annuum, nihilominùs nonnunquam infra ſectiones Cometa incedit.] *Although the trace of the trajectory does not cut the annual orbit, the comet nevertheless sometimes moves below the intersections.*

Secondly, in theorem XVI the same Kepler holds that if the trajectory trace does not cut the annual orbit, the comet must necessarily remain perpetually above the intersections, or below them. But the contrary [is clear] from the annexed diagrams XI and XII, where at first, with the Earth near A and the comet near H, the trajectory trace is above the intersections and the comet itself is retrograde; but when the Earth reaches D and E, and the comet L and M, it is direct, placed below the intersections of the lines of sight. Again, when the Earth is near F and G and the comet is near N and O, the comet is retrograde and stands above the intersections.

[Margin: Etiam Theorema 18 Kepleri vacillat.] *Kepler's theorem 18 also wavers.*

Thirdly, in theorem XVIII he thinks that a comet near the Sun in longitude, and retrograde, necessarily has a greater daily trajection than the Earth. But this is by no means necessary: for the lines of sight of two days can diverge while a shorter space lies between them than the Earth's motion covered; that is, if those lines of sight make an oblique angle with the annual orbit, and the trajectory is supposed to cut them at an angle not far from a right angle, as is plainly evident in the attached figure XII.

[Margin: Poteſt Cometa ex uno hemiſphærio in alterum transire, etiamſi ejus Trajectoria non ſecet Orbem annuum.] *A comet can pass from one hemisphere into the other even if its trajectory does not cut the annual orbit.*

Fourthly, in theorem XXVI the same author asserts: *if a comet after a station does not change its course for a long time, it is of immense height; as is also one that passes from one hemisphere into the other, in which the intersections lie, without itself cutting the Earth's orbit with its trajection.* The first part is indeed clear from our theorems 1 and 2; but the second is not absolutely true. For a comet can come from the hemisphere of the Sun into the opposite one, and conversely, even if its trajectory does not cut the annual orbit, and yet it need not be far distant from the Earth: this very point is likewise attested by the two diagrams XI and XII cited above, in this figure F f. But let this suffice; let us now come to the matters for which we have paved the way with the foregoing.

[Margin: ConcluditurCometas omnes moveri in lineâ propemodùm rectâ.] *It is concluded that all comets move in an almost straight line.*

Since, then, fully and clearly — in our judgement at least — in all those comets, namely, whose accurate observations have reached us, we have derived and demonstrated that all of them, each and every one, by a line, namely the trajectory line, far more easily and more fittingly than by any other method, whether by simple

Diagram. A full-page engraved plate, with no text on the page, carrying four circles numbered IX to XII: IX at the upper left, X at the upper right, XI at the lower left and XII at the lower right. Circle IX has a bundle of straight lines rising from its top and crossing above it, and a single straight line running up from its centre, marked as the trajectory. Circles X and XI each have a straight trajectory line running from the upper left down to the right above the circle, lettered at successive points, with lines rising from points on the circle through those points. Circle XII is crossed by a set of parallel lines running from the lower left to the upper right, with lines running out from it to the right; a line marked as the trajectory descends towards it from below circle X. Many points on the lines are marked with dots. The labels engraved on the plate:

- Circle IX: *IX* (in the lower half of the circle); *S* (above it), at the lower end of a vertical line with *Trajectoria.* written along it: Trajectory.
- Circle X: *X* (in the circle) and *S* (beside the vertical line at its centre); a line with *Trajectoria.* written along it: Trajectory, running down to the right above the circle and lettered in turn *O*, *N*, *M*, *L*, *K*, *I* and *H* (at its right end); on the circle, *A* (at the upper right, where a horizontal line

leaves it) and *B* (below *A*), *C* (at the right), *D* and *E* (at the bottom, right and left), *F* (at the left) and *G* (at the upper left).
- Between circles X and XII: a line descending to the right towards circle XII, with *Trajectoria.* written along it: Trajectory.
- Circle XI: *XI* (in the circle); a line running down to the right above the circle, lettered in turn *O*, *N*, *M*, *L*, *I* and *H*, with *Trajectoria.* written along its right end: Trajectory; on the circle, *A* (at the upper right) and *B* (below it), *D* and *E* (at the bottom, right and left), *F* (at the left) and *G* (at the upper left).
- Circle XII: *XII* (in the circle); no other label.
- *Fig. FF.* (at the bottom, between circles XI and XII): Fig. FF.
- *Autor ſculpsit.* (below it): Engraved by the author.

circles, or by superadded epicycles of various kinds, can be upheld and defended by us: hence, too, it is by no means at odds with right reason, nor does it seem contrary to the truth, that comets in reality also perform their motions in an almost straight line of path; [a view] that no one opposes, and that has moreover already been confirmed by us with certain reasons that are not so very trivial (namely on pages 587 and 588 of this Book).

[Margin: Vnde motus rectilineus Trajectorius originem trahat, atq; conſervetur.] *From where the rectilinear trajectory motion takes its origin, and is preserved.*

But since other, more evident and weightier [reasons] still remain, held over to this place, it therefore seems incumbent on us now to speak in detail and to pursue that rectilinear course most fully and duly: namely, from where this rectilinear, and indeed spontaneous, trajectory motion arises; and by what means it is propagated, preserved, destroyed again, and finally brought to a halt?

[Margin: Hæc quæſtio, uti aliarum eſt præcipua, ſic Philoſophos hucusq; maximè torſit.] *This question, as it is the chief of the others, so it has tormented philosophers most of all up to now.*

Beyond doubt, moreover, by our own vote and that of all others, this theme is almost the chief among the rest, and the most arduous and intricate that can ever be raised and thought out about comets; and it has tormented philosophers up to now. For although they have left no stone unturned and nothing untried, they have nevertheless in no way at all brought the matter to the point of entirely avoiding all the difficulties, inconsistencies and contradictions, and escaping all the snares; as Fromondus rightly judges (*Meteorol.* Book III, Chapter IV): *But what is the cause of this proper motion? Again the matter is hidden and cloudy.*

[Margin: Auctor agnoſcit ultrò ſuam tenuitatem.] *The author freely acknowledges his own feebleness.*

For this reason I by no means persuade myself — as one very well aware of my own feebleness — that I shall satisfy everyone in every respect, and advance so far as to leave nothing whatever behind me.

[Margin: Cuilibet incumbit de reb9 naturalibus dare rationes phyſicas.] *It is incumbent on anyone to give physical reasons concerning natural things.*

Nevertheless, now that we have come this far, we consider it our part as well to take diligent pains so that we too, according to the weak powers of mind granted by GOD, may put forward physical reasons from which all these things descend and are preserved, in accordance with the power of the comets' natural disposition. I do not doubt at all that, with GOD's favour, I shall bring forward at least some things that are not so very absurd.

[Margin: Veriori opinioni ſemper cedendum.] *One must always yield to a truer opinion.*

But if anyone is able to bring forth more fitting things, supported by more evident reasons, I shall lower my fasces and take back my vote. For I would have you know this: that the sole aim of my endeavour is to search out the truth to the glory of GOD, Best and Greatest. Hence I never cling so firmly even to my own opinion, much less to that of any Master, of whatever Authority he may be (in these physical matters, that is), that I would not most gladly yield to someone's truer view, confirmed by more solid arguments.

[Margin: Quâ ratione quàm facillimè motus Cometarum expediri poſſit.] *By what means the motion of comets could be dealt with most easily.*

Indeed, if I had a mind to conceive and treat the matter, following the tenets of many of the Ancients as well as of the more recent [writers], only so far as this: that this motion is to be ascribed to GOD, as the Prime Mover; or, with others, that comets are ruled and moved by Intelligences, or Powers, or Spirits, or Souls; or if we wished to refer that motion to occult qualities — then we would surely rid ourselves of all difficulties at a single stroke.

[Margin: Neutiquam decet Philoſophum illicò ad Aſylum divinæ omnipotentiæ confugere.] *It by no means befits a philosopher to flee at once to the asylum of divine omnipotence.*

But I am of the opinion that if anyone flees at once to this asylum — namely, to the Divine Omnipotence — it is a sure sign that reasons and powers of mind are failing him; and moreover that it is the greatest disgrace for philosophers who investigate natural things to take refuge in that sacred Anchor before there is nothing in the matter that they have not tried or searched out, [and found] that what was proposed to be demonstrated can be established by no physical reasons at all, in any other way.

[Margin: Cauſam primam motus Cometarum ipsū DEVM eſſe.] *That the first cause of the motion of comets is GOD himself.*

But if we had to deal with the first cause of this motion, I gladly acknowledge that GOD himself is the Creator and Mover of all things: here, however, we must speak not of that first cause but of the secondary causes of this motion.

[Margin: DEVS operatur mediantib9 cauſis ſecundis.] *GOD operates through the mediation of secondary causes.*

And so I am entirely resolved in my own mind that comets are not moved immediately by GOD, or by the Divine will alone; but that GOD acts, and

moves these bodies, through actions that proceed from omnipotence, and that GOD operates through the mediation of secondary causes. How this comes about, however, will have to be perceived from the questions to be discussed and raised: namely, whether comets are moved by themselves, or by another? Whether by their own intrinsic forms, or by some extrinsic virtue or power? Whether by some impressed motion or impetus, or by some propelling force, or by some magnetic attractive virtue? And from other questions of that kind.

[Margin: Vtrum Cometæ per ſe, an verò ab alio, & quomodo moveantur.] *Whether comets are moved by themselves or by another, and how.*

[Margin: Præmittenda ſunt certa Theoremata, quò negotium hocce eò faciliùs penetrari poſſit.] *Certain theorems must be laid down first, so that this business can be penetrated the more easily.*

But so that we may approach the matter in order and fittingly, and so that there may be no one who does not perceive everything the more clearly, the things that were set out and demonstrated here and there in Book VII, on which our Theory rests, must be briefly recalled here: by first laying down certain Theorems and Axioms that must of necessity be assumed by us beforehand, as the prop and pillars on which the whole subsequent edifice, for the motions of the haired stars, must be built; and they are so firmly established in nature itself that they can scarcely be attacked by anyone with sound reason.

[Margin: Omne corpus eſt capax motus & impetus.] *Every body is capable of motion and impetus.*

1. Every finite and natural body is capable of motion and impetus. Hence every body that is capable of motion is capable of impetus, and conversely.
2. Capable [bodies] conceive impetus, or a power of moving.

[Margin: Commotum, quatenus habeat vim ad perſeverandum in ſuo motu.] *That which is set in motion, in so far as it has a force to persevere in its motion.*

3. That each thing, as far as in it lies, always perseveres in the same state; and so what is once moved always continues to be moved, until it is retarded by other bodies, or destroyed by some external cause: and thus what is moved has a force to persevere in its motion (because each thing tends to remain in the same state in which it is), that is, in a motion of the same speed and in the same direction; unless — understand — it is impeded or accelerated by another motion supervening. Descartes, no common philosopher, has derived this at length and quite rightly in his *Principles of Philosophy*, Part Two.

[Margin: Vniverſa corpora ætherea continuò halituum vaporumq́; exſpirant effluvia.] *All ethereal bodies continually breathe out effluvia of breaths and vapours.*

Among other things, moreover, in its own place — namely in Book VII, where the origin and extinction of comets were treated in full — we have shown, and derived in a long series, that the individual Celestial globes are subject to generation and corruption as regards their outer parts; and that, from their essential property, they perpetually belch forth matter and breathe out certain

effluvia, as it were of breaths and vapours, which make up an Atmosphere, in order to purge and cleanse their body, just like the Earth.

[Margin: Corpora cœleſtia cum atmoſphærâ ſuâ indeſinenter in orbem aguntur.] *The celestial bodies are driven round in a circle unceasingly together with their atmosphere.*

Secondly: we have also determined, from definite observations and reasons, that all the eternal celestial bodies rotate about their own axis, and indeed together with their Atmosphere, which presents something like a vortex and is driven round in a circle with perpetual and unceasing motion. From this it follows that the matter which is evaporated and belched forth from those ethereal bodies — the Sun, namely, and the other planets — not only departs from them in a straight line, but also, while that ethereal body is carried round in a circle with its atmosphere, is itself always carried round as well, until it leaves the Atmosphere.

[Margin: Quomodo cum exhalationibus æthereis comparatum ſit, & quâ ratione iſtæ evaporationes in atmoſphærâ commoveantur.] *How matters stand with the ethereal exhalations, and by what means those evaporations are set in motion in the atmosphere.*

There is the further point that the matter in question, of exhalations and evaporations, celestial ones, is of the same nature as our Terrestrial vapours; and that it has an inclination and a natural propensity toward condensation, which afterwards, in its own time too, when it has come to maturity, is dissolved, so that it can flow back and return to its own source, from which that matter was drawn out, through that natural force implanted in the matter.

[Margin: Corpora homogenea,ex inſitâ virtute naturali ad ſe invicem feruntur.] *Homogeneous bodies are borne toward one another by an implanted natural power.*

For in homogeneous bodies there is always a certain quality by which their parts are borne toward one another, mutually attract one another, and tend to the same place: as we have pursued at greater length in that same Book VII.

[Margin: Quo pacto primus impetus in Cometis producatur.] *How a first impetus is produced in comets.*

Since, then — to come to the matter — it is altogether certain, and beyond all controversy, according to the First Principle stated a little earlier, that every body is capable of motion and of impetus, it is also worth the effort to say in advance, before we come to the first origin of cometary motions, in what way a first impetus is produced and motion impressed.

[Margin: Motus atq; impetus diverſimodè procreari poteſt.] *Motion and impetus can be generated in different ways.*

Now that motion and impetus can be kindled and produced for manifold reasons and in many ways: for instance by a blow, a percussion, a reverberation, a striking or an impulse of some animal or living being; or of some inanimate thing already movable, or engaged in motion. On these, however, I do not wish to set out much in this place, since it would be too lengthy, and would also

contribute little to this business; except that, among the rest, a motion can also be generated and emanate from circumgyration and circumrotation. How this comes about, however, and how motion proceeds from it, the matter demands that we indicate somewhat more fully: chiefly in view of the fact that the true and genuine principle of the motion of comets, in our opinion, depends on it.

[Margin: Ex vertigine inſignis motus atq́; impetus excitatur; & quâ ratione.] *A notable motion and impetus is excited by whirling; and by what means.*

That a notable motion and impetus can certainly proceed from circumgyration and whirling is already so well known and so widely spread that among the more expert it needs no great demonstration. For this can be made abundantly clear to everyone from the motion of some wheel or sphere, but above all from a stone cast by a sling.

[Margin: De naturâ fundi ejusq́; projectione.] *On the nature of the sling [?] and its projection.*

For who is unaware that stones thrown by a sling acquire an impetus, and indeed a far more vehement one, than those thrown by hand, because the sling is whirled round — something that cannot be done with the bare hand? For the hand is not carried round in a circle in that way; but in throwing, it describes only a certain proportion of a circle.

[Margin: Quò quid ma[?]gis in gyrum ducitur, e[[o/ò]] vehementiorem acquirit motum; & unde ?] *The more anything is carried round in a circle, the more vehement the motion it acquires; and from where [does this come]?*

The more often and the faster anything is carried round in a circle, however, the faster its motion becomes, and the greater the force impressed on it; according to the most universal principle: the more anything is rotated, the greater the force and impression of moving itself that it acquires; indeed, the longer the sling, the more vehement, too, are the impetus and the impressed force. This is because the motion, or impressed virtue, issues from a greater circle and is removed farther from the centre.

[Margin: Longioribus vectibus & ſcytalis majora & graviora moventur onera.] *With longer levers and spokes, greater and heavier loads are moved.*

For from the *Mechanics* — of Aristotle himself, too — Chapter 8, 9 and 12, we have thoroughly established that the longer the levers and the spokes in a drum are, or the axles in a wheel and axle, the lighter the load becomes and the more readily it is raised. For he says: *Greater circles are moved more swiftly by an equal power, and they move loads*; and again: *the more extended that which is from the centre, the more swiftly it is moved*: as has also already been derived more broadly by us in this Book. It should moreover be carefully noted that every motion, of itself, becomes straight; and that therefore things which are moved in a circle always tend to recede from the centre of the circle they describe, along a straight line; as Descartes, Cabeus and others rightly maintain. This motion is now also confirmed by the sling and by a channel, in which this motion and endeavour away from the centre is always increased. Hence, for as long as the circular motion and circumgyration, or whirling, lasts, so long

does that endeavour remain vigorous, and it is, as it were, renewed at every moment.

[Margin: In gyrum commota, tendunt perpetuò ut recedant à centro.] *Things set moving in a circle tend perpetually to recede from the centre.*

Since this is in fact so — that not only do things which are moved in a circle acquire a greater motion while they recede more and more from the centre, but also that all things fit for motion, and separable, when they are separated and freed from circumgyration or circular motion, bursting out as it were from the vortex, likewise retain the same motion of moving themselves farther: in accordance with that axiom: A projected body, separated from the moving power, is still moved.

[Margin: Corpus projectum à virtute motrice ſeparatum, quousq́; & quamdiu moveatur.] *A projected body separated from the motive virtue: how far and how long it is moved.*

And this motion, or this force of moving itself, is preserved for as long as nothing demands its destruction; not, indeed, in a circular course, as before, but in a straight line, and indeed in the tangent of the circle: as can be demonstrated by the nature of the sling, and of a pebble that has dropped out of a reed.

[Margin: Corpus quodcunq́; projectū à puncto ſeparationis movetur propemodùm per lineam rectam.] *Any projected body is moved from the point of separation almost along a straight line.*

For as soon as a stone leaves the sling or the reed, it proceeds from the point of separation along a straight line, and indeed along the tangent of the circle, if we understand the bare adventitious impetus. From this, every point acquires an impetus of moving itself along the tangent of the arc described by the motion of the thrower, at the point where the projectile itself separates from the thrower; unless it is impeded by some external cause, so that it is forced to bend aside elsewhere and to mark out a curved line. Likewise a wheel driven swiftly round in a circle also throws off the things adhering to it, as being things into which an impetus of moving themselves has been put by that circumgyration; and indeed in the same way, as we have said, along the tangent of the circle.

[Margin: Quælibet materiæ pars ſeorſim ſpectata, nunquam tendit ſecundùm lineas obliquas.] *Any part of matter, considered separately, never tends along oblique lines.*

For each part of matter, considered separately, never tends along oblique lines, but only along straight ones. This is abundantly evident in the mud adhering to the wheels of carts, and also in the water adhering to the wheels of mills turned round in a circle; although in the end both the mud and the water, projected in this way, at length describe another, different, curved line — but for entirely different reasons, namely from excessive weight: of which, however, we shall speak below.

[Margin: Quomodo mot9 alicujus corporis procreetur, propagetur, ac conſervetur.] *How the motion of any body is generated, propagated and preserved.*

It is therefore solidly founded in nature that any body fit for motion acquires successively, from gyration or circumrotation, a greater force or virtue of departing farther and farther from the centre toward the periphery; and that this impetus is so far intensified by that gyratory course, or whirling, that, although the movable body is separated from the periphery, it nevertheless fully retains that once-impressed power of advancing farther, and indeed along a straight line, or the tangent of the circle, from the point of separation. Moreover, a movable body of this kind is able, from a certain natural propensity, to keep itself constantly in the same motion, until obstacles meet it and disturb and destroy the motion once begun: in accordance with that principle III set down on page 644.

[Margin: Ratio cursûs, ſive motûs Crinitarum Stellarum.] *The account of the course, or motion, of the hairy stars.*

The case is surely the same in the motion and course of the haired stars. For as soon as matter, breaths, or evaporations burst out, or rather are expelled, from some celestial body — whether the Sun or some other planet — into the Atmosphere surrounding the planet's body, as we have shown in its place (inasmuch as celestial bodies continually breathe out a great many vapours and exhalations circularly, as we have likewise mentioned rather often in the earlier books) they acquire more and more the power of moving themselves farther from the centre, or from the planet itself, toward the periphery, by the action of that most violent whirling of the atmosphere, which is carried round in a circle, most constantly, together with its body or planet.

[Margin: Quo pacto motus primus materiæ Cometicæ inducatur.] *How the first motion of the cometary matter is induced.*

While this goes on, more and more matter is thrown out from day to day into the Atmosphere from the various parts of the planetary body, now this way, now that, according to the disposition and faculty of the body, or of the source from which they gush out. This matter, I say, likewise becomes possessed of the same power of advancing straight on to the periphery as that earlier matter breathed out from the body.

[Margin: Non omnis materia ad extremos usq; terminos atmoſphæræ pertingit.] *Not all matter reaches as far as the outermost limits of the atmosphere.*

Here, however, it frequently happens that this matter, rather than that, sets out more promptly and more swiftly and ascends to the outermost parts of the atmosphere, according to its quality — the more apt it is for motion: just as happens in our terrestrial exhalations.

[Margin: Ex quâ nonnunquam peculiaria meteora naſcuntur in atmoſphærâ.] *From which peculiar meteors sometimes arise in the atmosphere.*

Meanwhile, however — and I would have you note this — not all the evaporated matter reaches from the body to the periphery itself. For not every expiration is of such a constitution and compactness that it lasts as long as the rest; rather, it is quite often dissolved again in the atmosphere itself, on account of the rarity and thinness of the matter, before it can leave it; or else around the

Sun it is reduced to solar spots, and around the other planets to other peculiar meteors, according to the constitution of each one's Atmosphere (these were discussed in Book VII).

[Margin: MateriaCometica ut ut inæquali gaudet motu, tamen alia alii ſpont[[e/è]] adhæret.] *Although cometary matter enjoys unequal motion, nevertheless one [portion] adheres to another of its own accord.*

And so, since one portion of matter, accelerating its motion, frequently overtakes another, slower one on the way and matches its course; and since, besides, the parts are homogeneous, of the same nature and propensity, matter adheres to matter without difficulty, by a spontaneous inclination — while nevertheless proceeding strictly, all the while, toward the path that the stronger, more compact and greater part of the matter undertook at the start to pursue. For, as we have also stressed rather often in the book before this one, Book VII: in homogeneous bodies there is always a certain quality by which their parts are carried toward one another, mutually attract one another, and tend to the same place.

[Margin: Quâ ratione corpus Cometicum creſcat.] *In what way the cometary body grows.*

Therefore, as those expirations and effluvia of the planets depart more and more from the body itself, as from their centre, by means of that circular motion of the Atmosphere in which they are at that time situated, it happens quite often in that course and motion that other matter in abundance — more dilute, subtler, and somewhat slower to move — associates itself with another, more compact matter that is passing and gliding by, and that is moreover more inclined to motion. So much so, that that matter is extended successively, little by little, and grows in bulk (because, as you have learned, it adheres readily, from that innate natural virtue), at the same time condensing and compacting itself more and more as it advances. For that celestial matter, like our terrestrial matter, has a natural inclination and propensity toward condensation, as we have already touched on rather often.

[Margin: Corpora ſolidiora, aptiora ſunt ad motum.] *More solid bodies are more apt for motion.*

And the more that matter grows, coagulates and becomes denser, the more suitable and fitter for motion it is also rendered, and it acquires a greater impetus for pursuing its course. For more solid bodies, likewise, are more apt for motion than lighter ones, as we know well enough from nature itself. But it is pertinent to remember here, kind reader, that although I assert that the said matter becomes daily more solid and more compact, I nevertheless by no means maintain that the matter gathers itself into a ball about a single centre and grows equally all round into the shape of a globe — although of its own accord it strongly inclines by nature toward roundness — but rather that this matter coagulates and condenses about different centres, since effluvia are diverse according to the diversity of things, as here among sublunary things.

[Margin: An materia ſuper uno centro coaguletur & conglobetur.] *Whether matter coagulates and gathers into a ball about a single centre.*

For there are as many differences of effluvia as there can be species of things. And hence the cometary body, or head, mostly consists of very diverse nuclei, of matter now thinner, now thicker, which together compose a disc-shaped or spread-out body, but by no means a balled or spherical one.

[Margin: Materia quò magis à corpore ſuo elongatur,eò majorem impetum acquirit ſe movendi ulteriùs.] *The farther matter is removed from its body, the greater the impetus it acquires for moving itself farther.*

But to return to the motion: I say that the evaporation, or matter, while it is removed more and more from its body toward the periphery of the Atmosphere, not only gradually acquires a greater force of moving itself, but can also take on greater increments from day to day, as fresh matter is now and then found on the way that can flow in and join itself to it; so that it becomes at the same time more compact and fitter for obtaining and retaining a greater impetus — not only as far as the matter of the comet, or that fresh cometary body, stays in its Atmosphere, to the very outermost limits of the vaporous orb; rather, it also preserves the same impetus and motion even though it leaves the orb — in just the same way as a pebble thrown from a sling or a reed; and not, indeed, along the course of a circular line, but of an almost straight one.

[Margin: Vt lapillus è fundâ, ſic Cometa ex atmoſphærâ retinet vim curſum ſuum continuandi per tangentem circuli.] *As a pebble from a sling, so a comet from the atmosphere retains the force of continuing its course along the tangent of the circle.*

For every projectile, as we said above, driven swiftly round in a circle by the thrower, retains, when it is separated from him, the impetus of continuing its course along the straight line that touches the circle described by the thrower's motion at the point of separation. To this extent, then, this force of advancing themselves farther is likewise preserved in comets even when the cause of that first motion has been removed — that is, the atmosphere, by whose action the cometary matter acquired its impetus and motion, namely through its most violent circumrotation.

[Margin: Certis tamen de cauſis poſſunt Cometæ de ſuſcepto itinere deflecti.] *Yet for certain causes comets can be deflected from the course they have undertaken.*

For that reason, as anyone can now readily understand, comets do not abandon their course once undertaken, but firmly retain the path they seized upon about the time of their first birth, and the motion and impetus impressed on them then — unless they are deflected from that course by some other, external cause that supervenes. For any thing whatever, as far as in it lies, tends to remain in the same state in which it is, so that nothing that has been produced perishes unless a destroying cause is present: since no thing, or no being, destroys itself, just as it does not produce itself either. And so what is

moved continues, by its own nature, to be moved with the motion once taken up, until it is slowed by bodies in its way.

[Margin: Summaſententiæ Auctoris, de motu Cometarum.] *Summary of the author's view on the motion of comets.*

But, to sum up what has already been said at length, I assert this: that breaths and evaporations, or an effluvium coming from some celestial body, so long as it still wanders within the limits of its atmosphere, is whirled round circularly, or rather with a spiral motion, into the motion of a vortex, like things that are thrown into a vortex; but that, as soon as it goes out of the atmosphere into that free and most spacious ethereal field, it acquires a straight motion — as a stone whirled in a sling, and thrown out of it, goes straight to the mark; and moreover, from that whirling, an impetus for pursuing its course is fixed and impressed into the matter itself. It is no different with comets: first, from the circumgyration of the atmosphere, force and impetus are put into their matter, so that afterwards, once ejected into the most ample and free ether, they cannot fail to tend in a straight line.

This, then, is our view: namely, the way in which the first matter of comets, or the fresh cometary body, acquires motion both in the Atmosphere, or vortex, and how, once ejected from it and leaving it, it can preserve that motion, once impressed, as it advances.

[Margin: Corpus Cometicum eſt diſceum & extenſum[?] q[?]d alterutru[?] [?]us p[[l/i]]anum corpori ſuo, ex quo profluxit, tum etiam Soli obvertit.] *The cometary body is disc-shaped and spread out, which [?] turns one or other [?] [?] flat [?] toward its own body, from which it flowed, and then also toward the Sun.*

Here, however, we must recall once more what was set out at greater length in Book VII, page 419, on the origin and end [de Ortu & Interitu]: namely, that the matter of comets is spread out like a disc-shaped body, which, with one or other of its flat faces, mostly lies turned toward the surface of the body from which its matter flowed, so long, that is, as it stays in its own Atmosphere; but when it is ejected from it, or leaves it, it at once [turns] one or other of its spread-out sides (for it advances continuously at almost the same inclination, since all the planets acknowledge the Sun as their centre) toward the Sun, as toward the centre of the universe — just as clouds turn toward the Earth. In such a position, I say, and with such an inclination of its spread-out side toward the Sun, that fresh cometary body strictly and continuously pursues the course it undertook at the outset.

[Margin: Quâ ratione Cometa mole augeatur.] *How a comet increases in bulk.*

Moreover, it happens not rarely — as indeed it cannot happen otherwise — that this fresh comet, bursting out of the Atmosphere of Saturn, in crossing the sphere of Jupiter comes upon other matter, ejected here and there, for instance from Jupiter or from some other planetary body, and wandering through the ether. This matter likewise joins itself to that larger cometary body as it meets it, adheres to it and accompanies it — provided, that is, that this more dilute matter flowing in is smaller than that larger [matter] coming from the sphere

of Saturn. From this it comes about that this new comet gradually grows and increases from day to day, and the more so, the more abundantly other, diverse matter passes over and flies together to it from this or that planet.

[Margin: Cometæ circa Solem pleruńq; velociter excreſcunt.] *Comets near the Sun mostly grow swiftly.*

It is reasonable, moreover, that when that comet hangs close over the Sun, a very great quantity of solar matter, abundantly dispersed in that region, joins and adheres to it; by the action of this matter the comet swiftly grows to a very great bulk. Conversely, if very little matter joins that fresh cometary body on the way, it also increases little; so that very often, for this reason too, a great many comets do not come into our view at all, because of the smallness of the body and the thinness of the matter.

[Margin: Cometæ ex diverſis componuntur nucleis.] *Comets are composed of different nuclei.*

This matter now, in the course of time, coagulates and condenses in its own way, and flows together into different nuclei (according to the diversity of the matter of the different planets from which it flowed), with other, rarer and thinner matter mixed in; and so it forms a cometary body. Finally, once this body has attained maturity and its greatest density, after a certain time has elapsed (as happens to all temporal and perishable things), it is gradually dissolved and completely dispersed, as we noted before.

[Margin: Non omnis materia Cometica, versùs eandem Cœli partem [?]mmovetur,] *Not all cometary matter is [?] moved toward the same part of the heavens.*

You might object, however, that in the way, namely, just described, matter of this kind for a comet can arise in the vaporous orb of any of the planets (as indeed actually happens), coagulate, and obtain a motion strong enough for carrying its trajection forward; but I would hardly grant readily [that it moves] toward the same part of the heavens, except very rarely. Far more frequently, rather, that fresh matter — if any is fit for motion and endowed with a suitable density — makes for different regions of the heavens, since it bursts out now from the Atmosphere, or vortex, of this planet, now of that, and from this or that part of it; so that only very rarely, as we have said, can one [portion] take up another on the way. Indeed, it is not, I think, altogether foreign to reason that it should be possible some- times for different comets, newly born, leaping out of different atmospheres and performing entirely contrary motions, to meet one another head-on.

[Margin: Quid Cometis obveniat, qui ſibi obviam eunt.] *What befalls comets that meet one another.*

Since it could happen that such a body strikes against another with a motion in some degree contrary, it is asked, not without reason, whose direction and course one of the two would follow: whether the motion would be stopped altogether, or whether each would merely be deflected from the path it had

taken up; and what else befalls these bodies that are carried with a contrary, or a somewhat different, motion.

[Margin: Quomodo corporis alicujus motus occurſu alterius mutetur.] *How the motion of a body is changed by its meeting with another.*

On these matters I would have you know the following, which it will not be out of place to point out here: namely, that in truth it is entirely certain that a body, by meeting another, stronger body, loses nothing of its motion, but by meeting a less strong one it loses as much as it transfers into it.

[Margin: Theoremata de corporum occurſu.] *Theorems on the meeting of bodies.*

But so that the matter may be made still clearer and more evident, and so that no one may fail to grasp all the more correctly how the motions of each body can in part, and in part cannot, be changed by meeting with other bodies, I shall supply certain rules showing, that is, how the matter stands in this respect.

1. Equal [bodies], moved equally swiftly and meeting each other, are indeed deflected from the course they began, but without losing any part of their speed.

[Margin: Minus corpus reflectitur in contrarium.] *The smaller body is reflected in the contrary direction.*

2. If they are unequal in bulk, only the smaller [?] is reflected in the contrary direction, the other remaining on its own course.

[Margin: Celerius corpus confert ſegniori aliquid velocitatis.] *The swifter body imparts some speed to the slower.*

3. But if they are equal in bulk, and one moves a little more swiftly, then on meeting the other it imparts as much speed as it itself loses; and then both proceed together toward the same quarter in which the swifter body set out on its course.

[Margin: Minus corpus Commotum repellitur à quieſcente majori.] *A smaller body in motion is driven back by a larger one at rest.*

4. If a smaller body set in motion strikes against a larger one at rest, the former will never move the latter, but will be driven back by the body at rest in the contrary direction.

[Margin: Majus corpus Commotum movet minus quieſcens.] *A larger body in motion moves a smaller one at rest.*

5. If a larger body moves, though very slowly, and dashes against another, smaller one at rest, it would nevertheless move the latter along with itself toward the same quarter, equally swiftly, by imparting to it, that is, a part of its own motion.

6. If one of two equal bodies is moved toward the other, which is at rest, partly this [body] will be driven on by that one, and partly that [body] will be driven back in the contrary direction.

[Margin: Corpora diverſimodæ magnitudinis & velocitatis, quâ ratione moveantur?] *In what way are bodies of differing magnitude and velocity moved?*

7. But if two bodies were moving toward the same quarter, the one larger and slower, the other smaller and following faster, so that the proportion of the magnitude of the one to the velocity of the other is entirely equal, then, when they touch, they advance equally swiftly toward the same quarter. But if the proportion of the magnitude and speed of the said bodies is unequal, they do not proceed together; rather, one of them, according to the nature of this matter, is reflected in the contrary direction, retaining meanwhile all its motion.

[Margin: Quæcunq́; de corporibus ſolidioribus, ea etiam de mollioribus aſſeruntur.] *Whatever is asserted of more solid bodies is asserted also of softer ones.*

And these things, especially concerning perfectly hard bodies — if they were neither aided nor hindered by other, external causes — are so very true that they need no fuller demonstration, since anyone is able to try this very thing. But they can equally be understood, no less, of bodies that are not equally solid and are partly softer, indeed even of liquids, though according to the proportion, quantity and quality of each body. It is no different with the matter of comets, or with fresh cometary bodies. For each and every larger body, possessing both a more vehement and a swifter motion and impetus, necessarily carries along with itself, toward where the larger body is heading, some smaller body, whether that body is slower or swifter, even if it dashes into the larger body from any side whatever, even with a directly contrary motion; and most of all if the matter of each body is of the same nature, seeks conjunction and coming-together, and the one readily adheres to the other.

[Margin: Majus & velocius corpus Cometicum, minus ſecum fert.] *A larger and swifter cometary body carries a smaller one along with it.*

Although these things likewise hardly need any demonstration, let us nevertheless illustrate the matter with quicksilver.

[Margin: Res hydrargyro dilucidatur.] *The matter is illustrated with quicksilver.*

Set one or two drops of it moving toward opposite quarters; then, from the opposite side, drive a somewhat larger drop so that it falls squarely onto one of the earlier drops. There you will see that, as soon as the larger drop strikes the smaller, from whatever side this happens, whether obliquely or directly, not only has the smaller at once adhered to the larger, but it has also continued, together with the larger body, along the same path that this larger body, that is, entered on at the start: that is, the smaller body will entirely reverse its step and, as regards its first advance, will entirely abandon the motion it had once taken up. With equal ease, if the smaller drops, however many are present at the time, move toward the same direction as the larger body, at an unequal degree of speed, so that the smaller drops following behind successively catch up with the larger drop in the very course of its path, then, I say, all of them, joined together with the larger body, will head at an equal pace toward the same quarter and pass across, and indeed with the same velocity with which the larger body was advancing before.

[Margin: Juxta adſcripta Theoremata, tum ad exemplum Hydrargyri,Cometæ moventur.] *Comets move according to the theorems set down, and also after the example of quicksilver.*

In this way, I say, the matter of comets too advances, that is, the fresh cometary body that flows out of the particular atmosphere, or vortex, of some planet. When on its way it overtakes some other matter in its course, or runs into some and falls upon it, and this newly encountered matter is smaller in quantity and bulk, the matter at once associates itself with the larger cometary body and, abandoning the course it had previously been given, proceeds together with it, closely, in the path that the larger body, that is, has taken up; from whatever quarter that smaller body may come, and into whatever part of the larger body it may dash crosswise, and whatever other motion it may likewise be endowed with, swifter or slacker, it makes no difference. For any smaller body whatever, as soon as it has associated itself with some other, larger one, at once obeys the laws of this larger body, as a sharer in its power and motion.

[Margin: Non omnes Cometæ in oculos incurrunt; & quare ?] *Not all comets meet the eye; and why?*

But if very little extraneous matter, met here and there, comes to a fresh cometary body in its trajection, it also does not grow and increase so very much; so that, as a result, quite often very many bodies of this kind, because of the scarcity of matter and their own slightness, do not come into our view at all, but, as Seneca neatly says in Book 7 of the *Natural Questions*, *they are borne through hidden places and go in secret, never rising before human eyes*. And since it is most consistent [with reason] that an abundance of similar matter, able to receive and join itself together mutually, is very rarely present in any particular trajection. For the greatest part of the matters and effluvia, emanating from those various vaporous orbs of the planets, wanders everywhere and runs about through the whole aether, so that it can in no way at all be gathered into one mass. Hence it comes about that so rarely, and scarcely in the course of many years, comets conspicuous for the quantity of their body meet the eye: namely, from a lack of matter, because along that course of their path there is not present, or given, so much of the celestial evaporations for forming such very vast cometary bodies that they can strike our eyes. Not indeed, so that you understand this rightly, for the reason that no matter at all wanders here and there through the whole heaven; but only because that matter lies hidden, dispersed in various parts (and is, besides, too thin and less suited to condensation), can in no way come together, but one portion passes another at a distance and, by reason of its first impetus, sets its motion toward entirely different quarters, so that they move off from each other as far as possible.

[Margin: Similis ratio eſt effluviorum æthereorum, ſive intra ſive extra atmoſphæram exiſtentium.] *The principle is similar for aethereal effluvia, whether they exist within or outside the atmosphere.*

For the principle is the same in these exhalations and effluvia of the planets that leave the atmosphere as in those somewhat thicker ones that remain permanently within the atmosphere, just as we have quite often found around the Sun in those evaporations from which the spots are born and produced. For even if a very great deal of matter is ejected and expired from the solar body daily (as indeed actually happens), yet by no means always does so much matter coagulate, or can it flow together and combine into one mass, that such a spot, extremely conspicuous and remarkable, is generated.

[Margin: Cur non omni tempore maculæ generentur circa Solem.] *Why spots are not generated around the Sun at all times.*

Consequently, sometimes, even over a long interval of time, almost no spots are seen on the Sun: just as in quite a number of recent years, ten and more, apart from some rather slight and smaller ones, absolutely none that was very notable was observed, as far as I have ascertained, either by us or by others. By contrast, at other times, as the *Rosa Ursina* and the *Selenographia* bear witness, a great many, remarkable in bulk and density, appeared in a single year.

[Margin: Vno ſeculo quàm alio plures producuntur Cometæ.] *More comets are produced in one century than in another.*

Quite similarly it now happens with comets too: for in one century they are much more frequent, as was noticed in the preceding [century], 1500; in another, by contrast, such as the present one, they have been far rarer.

But, to return to the motion of comets: enough has indeed been said, I think, about how some particular cometary matter can lead and draw along with it other, different matter. But these things must be understood of those wandering aethereal effluvia and expirations (which are come upon by some cometary body) that have not yet attained their due maturity and condensation.

[Margin: Quid fieret, ſi duo perfecti Cometæ ſibi mutuò obviam irent.] *What would happen if two perfect comets were to meet each other.*

But when two or more mature and perfect comets, compacted out of more solid nuclei, or bodies, should come to meet one another, and one should strike against the other with its body, the matter would stand partly otherwise, yet in accordance with the rules brought forward a little earlier.

[Margin: Quod tamen haud facilè cõtingit.] *Which, however, does not easily happen.*

Although this can hardly ever happen, because of the immense and by far most ample space of the heaven, so that a convenient path and a suitable trajection lie open to any comet in every direction. Nevertheless it is not altogether foreign to reason that this can sometimes happen. It is no different than if only three or four ships were sailing on a most spacious sea: unless one were steered toward another by design, they would without doubt hardly run into one another by chance; and yet meanwhile it certainly can sometimes happen that one meets and strikes another.

[Margin: De Cometarum occurſu.] *On the meeting of comets.*

Suppose, then, that any two more solid comets were to meet each other on the way, but that one dashed against the other only obliquely and from the side, [being], moreover, of equal magnitude as regards body, and of the same velocity as regards motion: these, I say, accord- ing to Axiom I on p. 650, would be deflected to some extent from the path they had taken up; but otherwise each would pursue almost directly the motion impressed on it by its first impetus. If, however, the two cometary bodies were of unequal magnitude, only the smaller would bend its course aside from the line of its path, in accordance with Axiom II. Again, if by chance different cometary bodies were to meet each other head-on and directly (for example, one driven from the south, the other from the north), one of them nevertheless being larger than the other, then necessarily, if the smaller enjoyed equal density and more solid matter (which, however, can hardly ever happen), that very body would yield to the larger, and in such a way that it would at once be driven back in its turn, that is, toward the same quarter toward which the larger body was then heading, namely according to Axiom III.

[Margin: Ex alliſione alius Cometa in diverſas partes reſolveretur; & quâ ratione iſtæ partes tunc moverentur.] *From a collision another comet would be resolved into different parts; and in what way those parts would then move.*

But if each comet were not endowed with equal density (as can in fact happen more readily, since they are composed of different nuclei), it would then easily come about that, from that collision and encounter of these bodies, at least one of the two, if not both, would be resolved into different parts and portions, or broken; these parts would afterwards go off in different directions and be scattered here and there through the aether without law, until at last, in their own time, they vanished entirely.

I would readily believe that such a phenomenon has also been observed several times already in the past.

[Margin: Et olim tale quid jam obſervatum eſt àDemocrito.] *And something of the kind was observed long ago by Democritus.*

And indeed, first, in the comet that Democritus mentions in Aristotle, *Meteor.* 1, chapter 6, where one reads: *When the comets were dissolved, certain stars appeared.* Second: Ephorus testifies in Seneca, Book 7 of the *Natural Questions*, chapter 16, that the comet which by its rising submerged Helice and Buris split into two stars. Third: Dio notes in Book 54 that the comet which appeared under Augustus, at the death of Agrippa, went off dissolved into torches.

[Margin: Aliis exemplis comprobatur, Cometas in partes abiiſſe.] *It is confirmed by other examples that comets have gone off into parts.*

Something similar was detected in 1652, at the very beginning of that comet. For, as Father Joh. de Kôningk wrote from the Kingdom of Peru to Father Kircher, who in turn informed me of these matters: In the city of Paz, commonly [called] Chuquiabo, on 1652 December 15, a twin comet appeared, a third, very small one shining forth from one of the two.

[Margin: Anno 1652 tres Cometæ ſimul in Americâ obſervati ſunt.] *In 1652 three comets were observed together in America.*

But whether two of these were at once extinguished, only the third remaining, or whether they adhered to the larger one, subjected themselves to its course and followed it, nothing at all certain about this has become known to us. Meanwhile, however, it seems more probable to me that the latter happened, and that all three coalesced into one and took up the course of the larger body, since only a single comet came into our sight, on December 18, and one indeed with a head of rare and admirable magnitude. A phenomenon not unlike this was also recorded in the year of Christ 392, as Nicephorus attests, chapter 31, Book 2: namely, that very many most diverse, smaller little stars flew together to a certain comet: *to which* (says the author) *as bees to their king, a huge multitude of other little stars gathered.*

[Margin: Comet[[a/á]] Nicephori cx [recte: ex] variis corporibus conſtitit; atq́; ſic poſſe ex minutioribus corpuſculis corpus Cometicũ componi.] *The comet of Nicephorus consisted of various bodies; and thus a cometary body can be composed of smaller corpuscles.*

Indeed, what is more, in all comets examined with the telescope it has been clearly detected how the matter and the nuclei change and vary from day to day, and are reduced now into more, now into fewer, as has already been abundantly shown in its proper place. For that reason it is most true, beyond all contradiction, that manifold corpuscles of this kind can sometimes, to a larger cometary body of some kind pass over, join themselves with it, and so, conjoined, strictly pursue the path once taken up: which was to be proved.

[Margin: Vtiq́; poteſt motus Cometarum primus ex cauſſis naturalibus demonſtrari, ut minimè neceſſum ſit ad Intelligentias, vel ad abſolutam voluntatem Divinam confugere.] *The first motion of comets can certainly be demonstrated from natural causes, so that there is no need at all to take refuge in the Intelligences, or in the absolute divine will.*

No less clearly, likewise, have we shown from where comets acquire and obtain their motion and their first impetus at the beginning; and how, from natural principles and purely physical causes flowing in from outside, they can be moved in an almost straight line until they are dissolved. Yet very many most distinguished philosophers have so far strongly doubted that this very thing could be properly demonstrated: for instance, among others, Cabeus, Book 1, text 37, question 7, pp. 211 and 212. Since these things are not so very absurd, and do not altogether conflict with physical reasons, granted, that is, the principles on which this hypothesis of ours rests, no necessity therefore requires, in this matter, that for rectilinear motion we at once take refuge in and have recourse either to Intelligences and Angels, or to the divine omnipotence and the absolute will of God; much less that we lay down with Longomontanus that, if we wish to suppose rectilinear motion, it is necessary that comets be endowed with sense, and that some spirit preside over that motion; otherwise (he says) no probable principle of such a motion appears.

[Margin: An Cometæ omnes æqualibus temporibus æquale ſpatium itineris peragant.] *Whether all comets traverse equal stretches of their path in equal times.*

And so, since it has now, I think, been sufficiently demonstrated by us, from physical and necessary causes, that comets proceed with an almost straight motion, the question is now further asked: whether comets in fact always enjoy a similar proper motion that is equal, or an unequal one; that is, whether they advance equally in equal times, or unequally? First, I say that everything that is moved has a force for persevering in its motion, not only toward the same quarter but also in a motion of the same speed; that is, that the motive force in a thrown thing, or, what is the same, a motion once impressed, is always uniform by its own nature and of itself, so that a body once set in motion can cover exactly equal spaces in equal times; but on this express condition: namely, if that impressed motion were carried out through an entirely empty space, in which nothing would be found that might attract, hold back, or resist; and then, I say, a motion once impressed will always be uniform, indeed perpetual.

[Margin: Lapis projectus in motu recto aſſiduè pergeret, ſi nullum daretur impedimentum, vel obſtaculum.] *A thrown stone would continue unceasingly in a straight motion if no impediment or obstacle were present.*

For these reasons, too, a stone to which some impetus has been impressed, or which has been thrown by hand or by a sling, would go on perpetually and unceasingly in the direction in which the throw, or cast, was aimed at the outset, and indeed in a straight line, with an entirely uniform and, as I said, unceasing motion, if there were no resistance of the air and also no attraction of the Earth, on account of which the stone always tends toward the center: by reason, that is, of that natural inclination which we otherwise call gravity. And this is nothing other than a certain appetite of parts torn away, which desire to return to their whole and to flow together with it.

[Margin: Quâ de cauſa motus iſte parte incurvetur, um retar detur.] *For what reason this motion is curved in part, [?] retarded.*

But because, in the throwing of any stone, a resistance and some attraction intervene, that motion therefore remains neither uniform nor entirely straight, but is successively retarded, and is also thrown off that straight course, so that the straight line is bent aside in part and in a certain proportion.

[Margin: Cur motus Cometarum non ſit perpetuò æquabilis; ſed modò acceleretur, modò retardetur.] *Why the motion of comets is not perpetually uniform, but is now accelerated, now retarded.*

For the rest, since almost similar causes occur, resisting or opposing, and also attracting, or impelling and promoting, which, as the case arises, retard and impede the motion now more, now less, or accelerate it, the proper course of comets, once taken up, not therefore unceasingly uniform and of the same spe- ed can be: even though the first impressed motion, of itself, when [the comet] emerges from its atmosphere, is most uniform; that is, if comets were to pass through some empty medium, or a void. For even if you suppose the matter of the aether to be extremely thin, it is nevertheless nothing but the

purest air; and air has a most subtle body. Again, every body gives rise to and produces resistance and counter-pressure. Therefore, since comets are never borne anywhere but in the aether itself, and by no means in some empty space, a definite check is also set against comets, in its own way, by which their motion is in part inhibited and held down.

[Margin: Ob inclinationem diſci Cometici motus Cometarũ redditur inæqualis, tum ex parte incurvatus.] *On account of the inclination of the cometary disc, the motion of comets is rendered unequal, and also curved in part.*

Yet this is not the one and only cause on account of which the course of comets is rendered unequal; another, still different one is at hand, which has hardly ever yet entered the mind of anyone else: namely, the inclination of the disc, or of the cometary head. Owing to it, that motion is now quickened a little, now checked, indeed turned back, even though the impressed motion, with the cause of the resisting aether I spoke of a little earlier removed, would of itself plainly be most uniform. Moreover, this inclination and deviation of the disc thoroughly prevents comets, so that they cannot travel through in an altogether straight line (as would indeed otherwise happen, if this inclination and other impeding causes did not intervene), but are forced by necessity to deviate somewhat from the straight path of their journey. So much so that anyone may readily conjecture that comets not only enjoy an unequal proper motion, but also always advance in a line partly bent and curved, by no means entirely straight.

[Margin: De inclinatione apparente & reali.] *On the apparent and the real inclination.*

And indeed, again, not only on account of this inclination of the disc of the cometary body, but also on account of certain particular deviations (which we mentioned at the beginning of this Book IX), namely the apparent and the real: although the apparent one, which arises from the varied situation of comets with respect to the Earth and the Sun, has no place here, but only the real one, because we are now speaking of nothing but the true proper motion. For this reason we shall have to deal for the present only with the deviation of the inclination of the disc, bearing in mind that the other real deviations were likewise discussed at length at the beginning of this Book IX. This deviation, however, arising from the impressed motion and the inclination of the disc, we have reserved until this place (because solid foundations for introducing and establishing it had not yet been laid at that time). And so, now that everything bearing on this business has been abundantly brought forward and demonstrated, let us deliberately treat here and now of this inclination of the disc.

[Margin: Cur omnes Cometæ motu reali circa ultimã præſertim apparitionem à recto tramite devient.] *Why all comets, by a real motion, deviate from the straight path, especially around their last appearance.*

[Margin: Certo tamen loco Cometæ rectà omnino procedunt.] *In a certain position, however, comets proceed entirely straight.*

Above all, since the hinge of the matter turns on this, and almost the whole matter depends on it: namely, why comets for the most part, as their motion begins and again as it ends, that is, around their first and last appearance, deviate in part from their straight course by a real motion, so that almost none of the comets comes into our view which advances constantly along an entirely straight trace, however much it inclines and leans toward straight motion by a natural, implanted power; rather, they must advance with a motion curved to some degree. The only exception is a single case, namely when some comet, with respect to us, proceeds directly toward the Sun, or conversely is projected straight from the Sun toward the Earth; which, however, can happen only very rarely indeed, as will be shown below in its proper place.

[Margin: Caput Cometicum, ut corpus diſceum, ſic alterutram faciem planam Soli obvertit.] *The cometary head, being a disc-shaped body, accordingly turns one or the other flat face toward the Sun.*

So that everything may flow as we wish, it is necessary to recall briefly what was brought forward and demonstrated in Book VII, and also at the beginning of this one: namely, that the cometary body, or head, is not entirely spherical, but disc-shaped and flat on both sides, though having a thickness of its own. Then it was also asserted that a body of this kind moves in such a way that it turns the narrower side of its body, or its thickness, toward the region lying opposite, into which it is then being carried; but exposes one or the other flat and extended side to the Sun, as to the center of the universe, by a certain implanted natural power, just like our clouds, which float and flow through the air with one or the other of their flat faces spread out toward the surface of the Earth.

[Margin: Extenſum commotumq́; corpus nonnunquã à recto motu abhorret.] *An extended body, once set in motion, sometimes turns away from straight motion.*

Third: it was also demonstrated in the same place that any flat and extended body, even though it possesses a uniform impetus, or a power of moving itself in a straight line, is nonetheless forced to deflect from the straight path: namely, when it is thrown off, diverted and led aside by another, different impressed motion, or by some collision or encounter with some other body, or by some natural propensity, a magnetic force, or an attracting or propelling power. And [it was demonstrated] that this disc-shaped or flat-shaped body, while for these necessary causes it declines and strays from the straight way, is at the same time retarded more and more in its course, owing to the greater counter-pressure that follows from the medium, or aether, through which it passes; because, namely, one or the other flat side must, by reason of the course and impetus impressed at the beginning, turn itself more and more toward it, as we also clearly showed on p. 570 of this Book.

[Margin: Per velificationes optimè dilucidatur motus diſceorum corporum.] *By sailing, the motion of disc-shaped bodies is best elucidated.*

Above all, we explained by sailing and the rudders of ships how vessels can be steered and turned in another direction, even though the wind is not entirely favourable but partly contrary. From this, moreover, it was duly inferred that disc-shaped bodies, flattened on both sides, can be driven and thrown off a straight path once taken up, in the air and the aether, in just the same way as ships in water: since every disc-shaped body also has its own natural tiller, by whose help it can be steered and moved in another direction.

[Margin: Cùm corporibus Cometarum diſceis,motus aliquis realis inſit; idcirco à recto itinere deviantur.] *Since some real motion is inherent in the disc-shaped bodies of comets, they therefore deviate from the straight path.*

Accordingly comets too, as disc-shaped bodies, or disc-shaped in form, even though from their very first beginning, when they leave the atmosphere, they receive an entirely straight motion, can in a not dissimilar way be deflected from that straight path, to this side or beyond, now more, now less: namely, if some cause, either external or internal, occurs that brings this about and induces it. And indeed some real deviation befalls all comets: for instance from the gathering together and the dissolution of the bodies, or of the cometary matter; but above all from the inclination of the cometary body itself. But how these things are to be understood, and also where this aberration comes from, must now be stated.

[Margin: Quid ſit inclinatio diſci.] *What the inclination of the disc is.*

By the inclination of the cometary disc, however, I would have you understand this: that the haired star, although at the very beginning it turns its narrower and more compressed side along the continuation of the straight line along which it is cast out of its atmosphere, nevertheless by no means keeps its course most favourably with its sides unmoved, that is, by exposing one or the other narrower side, or the thickness of its body, directly toward the opposite parts; rather, it inclines its whole body little by little, successively, and indeed with one or the other side spread out, in this manner: that, where that side, from the beginning of its life, toward the direction parallel to that straight line along which it advances, it has ex- posed, afterwards, in its trajection, it gradually so disposes and directs that side that it forms an angle with respect to the trajectory, now successively greater, or more obtuse, now smaller, or more acute, as the occasion requires, as you will soon perceive more fully.

[Margin: Quid cauſæ ſit hujus inclinationis diſci.] *What the cause of this inclination of the disc is.*

[Margin: Cometa,caput ſuum aliter atquè aliter ſucceſſive inclinat atq; obvertit, reſpectu Trajectoriæ ſuæ] *A comet successively inclines and turns its head now one way, now another, with respect to its trajectory*

If we inquire into the cause of this, it is altogether this: that comets perpetually turn one or the other flat side directly toward the Sun, as happens (as we have touched on rather often) with the terrestrial clouds spread out toward the surface of the Earth; so that the line drawn from the center of the Sun to the center of the cometary disc always falls on the comet at a normal angle, or as

a perpendicular. Hence, in whatever direction the comet also sets its straight course in relation to the Sun, it nevertheless cannot do otherwise than expose one or the other flat face directly to the Sun, that is, at a right angle, and keep that face constantly in this disposition. Moreover, whether the comet is carried toward the Sun or away from the Sun, the disc must continually turn itself now one way, now another, and lean forward toward the Sun, that is, the center of the universe. For this reason the inclination of the disc in the trajectory varies constantly and unceasingly.

[Margin: Cur Cometæ alterutrum latus planum Soli exponant.] *Why comets expose one or the other flat side to the Sun.*

But before we go further, it will not be beside the point to recall what the cause is why comets always present one or the other flat, or spread-out, side to the Sun.

[Margin: Evaporationes quamdiu inAtmoſphærâ verſantur, ad corpus,ex quo prodiére, ſe inflectunt.] *Evaporations, as long as they remain in the atmosphere, bend toward the body from which they came forth.*

I say that it is the very same propensity, as has already been partly disclosed in its proper place, which slants the solar spots and the sublunary clouds toward the Sun and the Earth, as toward the body from which they flowed out; and which bends and curves the other breaths, vapours and effluvia that emanate from the remaining celestial bodies, as long as they remain in their own vaporous orb, toward the center of their own body, from which they flowed out. But, you will say, these things must be understood only of those expirations that remain within the limits of the atmosphere; perhaps a different account holds for those placed outside it? Not at all, except that these effluvia no longer incline toward the bodies from which they took their origin, but only toward the Sun itself.

[Margin: Effluvia corporum, tanquam partes ſunt ejusdem naturæ ac ipſa corpora, ex quibus profluxére.] *The effluvia of bodies, as their parts, are of the same nature as the bodies themselves from which they flowed out.*

For all the exhalations and evaporations of bodies are of entirely the same nature as the bodies themselves that produced them, as you will grant without difficulty. All the bodies of the planets, however, taken as a whole, look to the Sun as their center, about which they complete their periods by their own nature.

[Margin: Exſpirationes quamprimùm ex Atmoſphærâ egrediuntur, ſuperficiẽ planam Soli obvertunt.] *Expirations, as soon as they go out of the atmosphere, turn a flat surface toward the Sun.*

Hence their parts too, namely the expirations and effluvia produced and cast out from them, always strive to do the same and to show a similar regard toward the Sun, as far indeed as the impressed motion allows; so that, as soon as they go out of their atmospheres, or are thrust forth into that free and by far most widely open ethereal sea, they at once bend and twist one or the other flattened surface no longer toward the center of their own planet, but toward that of the universe, namely the Sun.

[Margin: Vnde fit, ut Cometæ neutiquã in rectâ lineâ tranare poſſint; ejusq́; motus retardetur ac deniq́; ſiſtatur.] *From this it comes about that comets can by no means travel through in a straight line, and that its motion is slowed and finally brought to a halt.*

Therefore, even if the first impetus along a straight line has been given to these ethereal vapours, or comets, so that they could move strictly with the narrower side of their disc-shaped body toward the forward parts, nevertheless that cometary disc, as it goes, at once twists itself little by little in such a way (since it has already come forth from the atmosphere at almost the same inclination) that it spreads out one or the other flat face, as we have often insisted, straight toward the Sun, at an orthogonal angle.

Since, therefore, comets accomplish their course in this way, namely with their flattened face turned toward the Sun, it cannot happen otherwise than that the thickness of the cometary body, or its narrower side, directed toward the preceding parts with a favourable motion, in relation to this straight path, must little by little decline and deflect more and more: on this account not only is the orbit curved in part, but the motion of the comet is also inhibited, so that it gradually fails and finally stops; as was explained more fully at the beginning of this Book from the tillers of ships under sail, and from certain principles set out there concerning the motion of disc-shaped bodies.

[Margin: Corpora diſcea commota, quò magis latus planum Trajectoriæ obvertunt, eò magis in curſu impediuntur, atq́; à recto tramite exorbitant.] *Disc-shaped bodies set in motion are the more impeded in their course, and stray from the straight path, the more they turn a flat side toward the trajectory.*

Above all, however, it becomes clearly evident from Principle III, p. 571 of this Book, that every disc-shaped body that moves forward with its thinner side is the more impeded and stopped in its course, the more, in passing through, it turns one or the other flat side, at the beginning parallel to the trajectory, toward the line of travel it has taken up, and opposes that side to it, and so struggles against its course; and moreover that it strays the further from the path once taken up, the less it keeps that thinner and pointed side turned toward its course as at the beginning. This was derived and demonstrated at sufficient length in the same place, from the steering of ships and the setting in motion of some disc-shaped body, and to it I refer the Reader. Since all those things, on which the whole nature of the motion of comets depends, have been treated so fully solely for the sake of this matter.

[Margin: Cometæ quia corpora ſunt expanſa,ideoq́; nullo modo in lineâ omninò rectâ moventur.] *Because comets are expanded bodies, they therefore move in no way in an entirely straight line.*

From these things it is now at last understood once again, more than sufficiently, that since the bodies of comets are disc-shaped, and hasten on their course by no means in some entirely empty space, but in the aether, that is, in the purest air, which, though it is most subtle, nevertheless has a body, their

motion can therefore neither be perpetually even and uniform, nor move continually in an entirely straight line, even though the first impressed impetus is altogether straight; but that, above all by reason of the inclination of the disc and its propensity toward the solar body, it declines and deviates somewhat from that straight path.

[Margin: Trajectio ſemper ad Solem incurvatur.] *The trajection is always curved toward the Sun.*

Therefore it is most necessary that comets take up and complete their course by no means in an exactly straight line, as indeed Kepler and others have supposed, but in a line partly inflected and curved, whose concavity perpetually leans toward the Sun (which I would have you note well).

[Margin: Rationibus atquè exemplis demonſtratum eſt, Cometas motu inæquali ferri in Trajectoriâ.] *It has been demonstrated by reasons and examples that comets are carried with an unequal motion in the trajectory.*

And that all these things really are so has been abundantly demonstrated, not only by sufficient reasons brought forward here and there in this Book IX; it is also proved clearer than daylight by those nine comets above, submitted to a rather strict calculation and examination, whose more accurate observations have come down to us: namely, that their proper motion along the path of their journey, or trajectory, is not altogether and universally equal, but is at times slower at the beginning and the end than in the middle, and at other times again faster at the start and at the last than in the intermediate appearance; as is plain from all the tables placed above (under the title: True motion of the comet in its trajectory).

[Margin: Trajectoria Cometarum nonnihil incurvatur.] *The trajectory of comets is somewhat curved.*

For it becomes known from the latitudes derived in that place from the hypothesis (as I also pointed out there rather often) that the trajectory in all those nine comets was not entirely straight, but curved in part, in accordance with Theorem 17 of this Book, p. 641. So much so that all the examples of all those comets that exist, whose observations were properly and duly carried out, confirm and establish both points, and that it never turns out otherwise: which is what we had to demonstrate.

[Margin: Variæ quæſtiones deTrajectione Cometarũ.] *Various questions about the trajection of comets.*

From these, now, questions arise that are most delightful and at the same time most subtle and most profound: namely, first, what the line really is, that is, that path of the journey: since it is in part inflected, and by no means constantly tends straight on, the line, that is, in which comets are otherwise carried across? Second: whether the same curvature of those lines occurs in all comets? Third: toward which side the obliquation tends; whether by chance, or rather for definite causes, and for which causes this happens? Fourth: whether the motion is always unequal in an entirely similar way? Fifth: whether all comets, at a given place in their journey, enjoy an entirely equal speed or slowness, or rather

each one sets up its own particular course; and when, how and why? Sixth: with what speed they are carried in the trajectory, as regards their true motion? And very many other questions of this kind, all of which we have proposed to treat fully in what follows, as occasion offers, with the help of the Divine Power.

[Margin: Trajectoria cu. jus generis ſit linearum curvatarum.] *Of what kind of curved lines the trajectory is.*

For the present, however, let us begin with the first of the remaining [questions], where it is asked: what kind of line is it in which comets set up and complete their course? For it has been grasped to the point of satiety, and also confirmed by all those examples of comets brought forward above, that the path which comets follow in their course is by no means entirely straight, but is made oblique in a certain way, or curved, chiefly as a result of the inclination of the cometary disc; so that as a result comets are compelled, by a certain definite law, partly to deflect and deviate from a straight line of travel.

[Margin: Cometæ univerſi moventur in lineâ parabolicâ.] *All comets move in a parabolic line.*

To sum the matter up in a few words, I am entirely of the opinion that all comets move in a conic line, and indeed a parabolic one. But just as very few, without any doubt, will allow themselves to be persuaded of this assertion of ours, and not very readily, so on the contrary very many will attack it sharply: namely, that such a parabolic motion can occur in the highest aether itself. [They will do so] chiefly because they scarcely believe that motion of this kind has any place at all among sublunary things, or indeed in the whole of nature. Therefore it now seems incumbent on us to show briefly, as far as this place allows, for what causes and reasons this can happen in comets.

[Margin: Demonſtratur non ſolùm in æthere, ſed etiam in aère motum parabolicum locum habere.] *It is demonstrated that parabolic motion has a place not only in the aether but also in the air.*

I say, therefore, that to all who look somewhat more deeply and more carefully into the nature of things, and who have a somewhat greater concern for hidden and abstruse matters than the common crowd of philosophizers, who otherwise cultivate the sciences at second hand and settle questions by the rule of their master — to these, I say, it cannot be entirely unknown what has now at last been fully demonstrated: that a parabolic or hyperbolic motion of that kind also occurs in these lower regions, around earthly things; indeed, that everything set in motion by any violent motion, or shot out, and also everything that falls or is sent forth from on high by natural motion, moves and is carried only along a parabolic line, and by no means along an entirely straight one, as indeed the Peripatetic School has long harped on; and moreover, that almost no pure and bare straight motion occurs in the whole of nature, according to our opinion as well as that of very many philosophers.

[Margin: Nullum ferè motum omnin[[ò/ó]] rectum in tot[[â/à]] naturâ dari.] *Almost no entirely straight motion occurs in the whole of nature.*

For although nature does not altogether abhor that rectilinear motion, it is nevertheless corrupted and hindered by accidents, so that it never, indeed, proceeds entirely straight on.

But it will not be out of place to discuss these things somewhat more fully, since they not only contribute greatly to our purpose, namely the matter of comets, bu- t also the whole of that business can be made exceedingly clear by them.

[Margin: Globus è tormento explosus, quâ lineâ feratur.] *Along what line a ball shot from a cannon is carried.*

And so let us first make mention of that motion of a certain ball shot from a cannon by the force of nitrous powder, or rather driven out by means of rarefied air: this ball, I say, describes no other line than a parabolic one, or one differing from it only very slightly. For the more exact investigators of physical things, and the deeper hunters of nature, have found and confirmed quite abundantly by most certain experiments that, if some cannon, or bombard, or musket were aimed along a course entirely parallel to the horizon, and thick or thickened paper, or stretched linen, were set opposite the cannon or bombard at very many distances, equally removed from one another and suitable, the balls sent out or shot from them pass through and pierce the papers set opposite, or the linens facing them, differently each time, and indeed the farther ones successively somewhat lower; so much so that the line of motion of that little ball is plainly a parabolic line, and by no means a straight one.

[Margin: Lineam motûs globorum non esse simpliciter inclinatam.] *That the line of motion of the balls is not simply inclined.*

That the motion of that shot ball, however, is not some simply inclined line, one that forms an angle with the line of direction or the axis of the tube, is clear from this: the distances of the holes made in the papers or linens would necessarily have to stand away from the points of the axis of direction always by twice as great a distance. This is an evident, indeed an infallible, argument for the more learned, such that no further one can rightly be called for.

For the others, however, a thicker work would be needed for the very thing I was just asserting to be fully demonstrated; but that would be too long in this place.

[Margin: Nec circuli sectionem esse; evidenti argumento comprobatur.] *That it is not a section of a circle either; this is proved by an evident argument.*

Second, that trajection is not a section of a circle either: for otherwise the distances of the holes made in those papers set up opposite would have to grow by increments according to the laws of tangents and secants; but the increments of the deviations from the direction of the tangent by no means come about in this way. Therefore it is neither a simply inclined line nor a section of a circle.

[Margin: Globum explosum lineam describere parabolicam, unde constet ?] *How is it established that a shot ball describes a parabolic line?*

But that the line which the shot ball marks out is entirely parabolic is demonstrated not only by those holes pierced by the ball in the papers or linens, but

also by many other experiments: since those holes constantly grow or diminish in accordance with that conic motion. For at the first sheets the ball declines little from the horizontal line, but at the later one strongly, although they are set apart from one another at equal intervals.

[Margin: Quid ſit ſectio parabolica.] *What a parabolic section is.*

What kind of section the parabolic section is, I do not wish to go through here at greater length, since I suppose that all who are versed in geometrical matters already understand it well: namely, that it is a section of the cone that descends from the vertex toward the base along a course parallel to one of the two sides, so that it never meets the other side of the cone.

[Margin: Omne projectum & exploſum motu parabolico progreditur.] *Everything thrown and shot proceeds with a parabolic motion.*

But as for what is shot or thrown — whether the casting or hurling is carried out by hand, by a sling, by a pipe, or by any other external force whatever, it makes no difference, provided only that it is directed entirely forward and straight (of which more clearly shortly) — that it proceeds along a line, and indeed a parabolic one, but of different species, which arise now from a more acute, now from a more obtuse cone.

[Margin: Motus parabolicus aquis hydraulicis, ignibus pyrobolicis, & meteoris ſublunaribus demonſtratur.] *Parabolic motion is demonstrated by hydraulic waters, by pyrobolic fires, and by sublunary meteors.*

First, it is confirmed by leaping waters, or waters springing out of hydraulic pipes. For that water, bursting out at some inclination, is curved at the vertex like a parabola in its upper or farther part, where it falls again; but the more that water descends toward the horizon, the straighter it glides:

just as at its outlet it is bent, successively and little by little, more and more, up to the vertex of that parabola traced by the course of the water. Second, the same thing is also clearly evident from technical pyrobolic fires, such as artificial fiery darts, or fiery missiles made by the art of the fireworkers, balls from a mortar, and ballistae, if they are launched at night; and likewise from certain sublunary meteors, namely falling stars, arrows, lamps, and burning torches passing through the air.

[Margin: Quâ ration[[e/è]] parabola deſcribatur in omni projection[[e/è]] ad horizontem parallelâ.] *In what way the parabola is described in every projection parallel to the horizon.*

In all of these, at all times, a parabola is described in such a way that, whenever anything is aimed along a course parallel to the horizon (e.g. a cannon or a bombard), the first side of the parabola invariably tends downward, or away from the line of direction toward the horizon, so that this line of direction, the axis of the tube, is tangent to the parabola, and so the vertex of the parabola always lies below that tangent.

[Margin: Projectio, quò vehementior, eò remotior eſt vertex parabolæ à puncto ſeparationis.] *The more vehement the projection, the more remote the vertex of the parabola is from the point of separation.*

Next, the more vehement the throwing or projection, the more remote is the vertex of the parabola of that motion, both from the line of direction of the bombard and from the very point of separation, when the ball leaves the bombard.

[Margin: De trajectionibus & explosionibus, quæ sub certo angulo accidunt.] *On trajections and discharges that take place at a certain angle.*

The matter stands the same way when something is launched upward at a certain elevation, except that what I was just asserting of the line of horizontal direction must now be understood of the perpendicular line descending from the point of the zenith. That is: the parabola always tends toward the side to which the inclination of the tube or musket leans, and it describes a parabola that is the more acute, the higher the tube is directed, through more degrees, toward the perpendicular line; on the contrary, it marks out a parabola that is the more obtuse, the less it is raised from the horizon, or, what is the same, the more the cannon or mortar declines from that perpendicular line toward the horizon — as anyone who weighs all these things somewhat more accurately easily understands.

[Margin: Quomodo motus fiat parabolicus in directione horizontali.] *How the motion becomes parabolic in a horizontal direction.*

But so that you may at last grasp the matter correctly, I say that the motion of all projectiles, namely in a horizontal direction, takes place along a parabolic line beginning at the bottom of the parabola, at the end of the ordinate [lineæ ordinatim applicatæ] that cuts the parabola at the exit from what projects it; and by no means at the top of the axis of the parabola, or around its vertex; but that the projectile is curved more and more toward the Earth at the vertex.

[Margin: Explosa & projecta,unde nonnihil à perfectâ sectione parabolicâ deflectant.] *Why things shot and thrown deflect somewhat from the perfect parabolic section.*

And yet, if we consider the matter still more strictly, thrown balls and shot arrows, and likewise leaping waters, do deviate and deflect somewhat in their motion from the perfect parabolic section. And indeed for this reason: that this motion can in no way be carried out in an entirely free medium; hence they are drawn aside and bent away a little from perfect parabolic motion by the resistance of the air. Although these things are most true, there is nevertheless no need on this occasion to treat the matter scrupulously and subtly.

[Margin: Motus parabolicus ex duobus motibus contrariis oritur.] *Parabolic motion arises from two contrary motions.*

That every projectile is carried with a parabolic motion, and completes its course in the manner described, proceeds chiefly from two reasons and motions, and indeed almost contrary ones. Of these, the one is that impressed motion, and indeed a violent one, deriving from any external cause whatever, from which a thing acquires an impetus of moving itself: it is impressed on projectiles along a straight line, or tangent, as we have shown above, when

they are thrown or hurled from a sling, or from a rotated circle, or a sphere swung round.

[Margin: Initiò motus impreſſus, ſive vis impellens fortior eſt.] *At the beginning the impressed motion, or impelling force, is stronger.*

This motion, by its own nature, among terrestrial things, is always more vehement at the outset than at the end: as Gassendi too, in Letter 1 on the transported mover [Motore translato], rightly argues: *The impressed force* (he says) *impelling at the beginning impels vehemently; but afterwards more and more sluggishly, since some degrees are always being taken away from it.* After that, this [motion] continually decreases, for definite causes which we have also already treated more fully in their proper place. But the other motion that occurs in projectiles is the gravity of any thing, namely of a stone, a ball, etc., fit for motion, that is, endowed with suitable gravity so that it is not made the plaything of the air, from that innate, intrinsic cause which inheres in it.

[Margin: Quid ſit gravitas.] *What gravity is.*

This is otherwise nothing other than an appetency, or magnetic force, by which parts torn away and separated from their whole return again, or are brought back, to their entire body; and all things are preserved in the state and order in which they were created.

[Margin: Motus gravitatis ſenſim invaleſcit, prout alter impreſſus paullatim debilitatur.] *The motion of gravity gradually grows stronger, as the other, impressed motion little by little weakens.*

This motion of gravity, however, is of such a nature that, just as that other one is violent and gradually weakens, so this one is natural and little by little grows stronger; so that at the beginning it is slower, but is successively accelerated, and the more so the nearer it approaches the horizon, or the Earth, that is, its place of rest.

[Margin: Motus violentus impreſſus, motum naturalem principiò antecellit.] *The violent impressed motion surpasses the natural motion at the beginning.*

So when anything is hurled or thrown forward and straight, the impressed or violent motion overcomes and surpasses this natural motion arising from gravity (however much it resists it, as far as it can), as happens in all projections. Accordingly, the very thing that is thrown or propelled necessarily tends straight toward where it is aimed, along that line of direction, and indeed much more straight at the beginning than afterwards, as it advances farther; whether it be a stone thrown through the air from a sling or a ball shot from a bombard, it makes no difference. For the impressed motion is more vehement and stronger at first; but after it gradually decreases, by reason, namely, of the medium of the air and its resistance, the projectiles little by little begin to exert their native forces, which by gravity always tend downward toward the Earth, and gradually to withdraw their course and deflect it toward the horizon from that straight line of direction which the impressed motion, by a certain violent motion, as it were impressed on the same thing.

[Margin: Vltimò verò motus naturalis, violentum motum prorsùs deſtruit.] *But at last the natural motion entirely destroys the violent motion.*

This motion, now natural and downward, grows successively more and more, the more that other impetus slackens, until this violent one loses all its force (the natural prevailing) and the projectile itself reaches the ground.

[Margin: Motus projectorum ex motu recto & inclinato componitur.] *The motion of projectiles is composed of a straight and an inclined motion.*

But to set the matter out still more clearly: this motion of projectiles consists of two motions contrary to each other, namely a violent, direct one and another, natural, inclined one, which indeed ought also to be straight; but because it is continually hindered by a certain impetus, it becomes as it were curvilinear, and to such an extent that it is compelled of necessity to imitate a parabolic line, since it is composed partly of straight motion and partly of circular.

[Margin: Ex duobus motibus rectis, tã parabolicus, circularis, quã ellipticus deſcribitur.] *From two straight motions a parabolic, a circular and an elliptical [motion] alike are described.*

Even supposing that this natural downward motion is entirely straight, a section that is parabolic as well as circular, or of any other figure, can nonetheless be described from two entirely straight motions, according to Proposition 23 of Mersenne's *Mechanic*., page 82: *Straight motion* (he says) *can be composed or produced from motions of any figure whatever, just as circular, parabolic, or motions of any other figure whatever can be composed or generated from straight motions having a definite ratio to one another.* This is easy to demonstrate from the description of a certain elliptical figure, if from two centres, or foci [umbilicis], by means of two rulers, or of a certain thread attached to each focus, you draw that figure, or also a parabola, while keeping, however, a due proportion between these two lines, but one that is perpetually unequal: as can be read in Apollonio Catto, pages 81 and 82, in Mydorgio, 102, and in other writers on the segments of the cone.

[Margin: Dato impetu, datur motus parabolicus.] *Given an impetus, a parabolic motion is given.*

I now say that this parabolic motion lasts as long as some of the impressed impetus persists in the ball; but when it entirely vanishes, or is stopped, then nothing remains but that single straight downward [motion] which arises from gravity.

[Margin: Copernicæi nullum in naturâ concedunt, motum rectum.] *The Copernicans allow no straight motion in nature.*

And yet the Copernicans hold that not even this one is entirely straight, as will perhaps be said at more length in its proper place.

From this it is clear that a ball shot from a bombard is at the beginning both straighter and stronger at keeping itself on a straight line.

[Margin: Omnis motus parabolicus initio & in fine rectior; in medio ver[[ò/o]] curvior eſt.] *Every parabolic motion is straighter at the beginning and at the end; but in the middle it is more curved.*

Accordingly, the parabolic motion too is likewise straighter at the start; but the longer it lasts, the more curved it becomes, downward and away from the line of direction, until the impetus of the ball begins to yield to its gravity. Then this motion slants itself more and more, so that at that very place it forms, as it were, the vertex of the parabola, and consequently, after that, its other side; this side, however, becomes successively straighter, because the impetus little by little weakens. And yet in a horizontal direction a section of the parabola is not described quite as fully complete as indeed happens at a greater elevation of the line of direction, because of the nearness of the horizon [finitoris].

[Margin: Quando ſurſum vel deorſum ad perpendiculum exploſis, projectis, vel ex alto cadentibus, pariter motus competat parabolicus.] *When a parabolic motion likewise belongs to things shot or thrown upward or downward along the perpendicular, or falling from a height.*

[There is] an entirely similar parabolic motion in those things that are thrown, hurled, or fall along a perpendicular line, either upward or downward toward the Earth, as in those just mentioned which are shot and propelled in a horizontal direction, or at some definite elevation. But understand this: whenever a projectile goes out by the power of some thing in motion, whether animate or inanimate, it makes no difference whether it is shot, thrown, thrust out, hurled, or set in motion in some other way.

[Margin: Pila è commotâ manu,in altum projecta, recidit in eandem manum.] *A ball thrown upward from a hand in motion falls back into the same hand.*

For example: holding a play-ball in your outstretched hand, run as fast as you can; and while running, throw that ball straight upward along the perpendicular, without, however, any slowing of your body or of its course. You will find that, however high you may have hurled the ball straight up, even as high as you possibly can, it nonetheless falls back and returns exactly to the same hand. The same comes about in a like way if ever a stone falls down to the ground from a raised hand while you are running: for that stone will invariably fall at your feet, not otherwise than if you threw a ball upward with your hand and body at rest.

[Margin: Lapis ad perpendiculũ projectus, quâ ratione in navi commotâ ſe ſe habeat.] *How a stone thrown along the perpendicular behaves on a moving ship.*

We also find something similar on a ship, whether it is carried along very swiftly or is entirely at rest. That is, if you send a stone straight up at the foot of the mast, the stone mentioned, or that projectile, will always (which is remarkable) keep the same distance from the mast, both in rising and in descending, and will fall back to exactly the same place. It is just as if a stone were let go, without any force, from the top of the mast onto the ship, whether the ship is standing still or under sail: that stone, I say, would invariably glide down to the foot of the mast, and to the same place. This can now be tested by yet another, most delightful method. Sitting on a horse, or a sledge, or a carriage, let a stone drop from your hand; whether these are carried or driven

forward with a rather vehement motion, or on the other hand are entirely at rest in place, it will make no difference: you will see at all times the stone fall always into the same place, so that neither the swiftest running nor the most complete rest can add anything to that motion, or take anything from it, to make it incline more toward the front or the back, or imitate less constantly the hand by which it is held or thrown, and the motion of its moving body.

[Margin: Sive lapis à quieſcente, ſive commotâ potentiâ projiciatur perinde eſt.] *Whether a stone is thrown by a power at rest or by one in motion, it makes no difference.*

[Margin: Quicquid movetur, motum ſuum imprimit rebus omnibus, quas ſuſtentat.] *Whatever is moved impresses its motion on all the things it supports.*

For *whatever is moved impresses its motion on all the things it supports; and the things are sent out in the same way whether what sends them has its motion from itself or has it impressed by another.* So Gassendi rightly and at length maintains in Book I, on motion impressed by a transported mover [de Motu impreſſo à Motore translato]; I refer there the reader who wants fuller instruction on this matter.

[Margin: Vnde corpora projecta, vel decidentia nullum motum rectum, ſed parabolicum deſignent.] *Why bodies thrown or falling trace no straight motion, but a parabolic one.*

From this it can be clearly understood that every projectile which is thrown, or falls, in some motion of another thing that is in motion describes by no means a straight line, but a curved one, or rather (if we take the matter precisely) a parabolic one. But you rightly ask here: where do these things come from, and what is the genuine reason for this? Namely from this: that all projected things, or things falling of their own accord, not only at last fall downward by natural motion, but also, from the impressed motion that tends toward the front (while some thing, such as a ship, a carriage, a horse, or some runner, is moved or carried forward), acquire the force and impetus to follow the thrower in the same direction. So this parabolic motion arises from nothing other than the fact that the thrower is moved in that motion; and in that motion any projectile whatever, whatever adheres to him, or he himself holds or throws, obtains the same forward motion, or the force of moving itself in the same direction, even when separated from that thrower.

[Margin: Projecta & exploſa progrediuntur ſemper motu parabolico.] *Things thrown and shot always advance with a parabolic motion.*

Therefore all projectiles that are hurled, thrown, or shot in motion, or while running, necessarily advance and fall along parabolic lines. Otherwise, surely, a ball or a stone would never follow the hand of a thrower in motion, or of one running, and fall back into it again, unless this motion took its origin from the transported mover, which impresses the same motion on the projectile.

[Margin: An detur aliquis in naturâ motus rectus ?] *Whether there is any straight motion in nature.*

It is therefore abundantly clear that in all projectiles no straight motion at all is found, but by its own nature a parabolic one. But, you will say, by this reasoning (perhaps in your opinion), in all things thrown, hurled, or shot straight upward along the rule of the perpendicular line by a thrower at rest and unmoved, or let go of their own accord from a very high place, namely a tower or a mountain, there will be no impressed motion at all for tracing any curved motion; but all of them will return again, only along a bare straight line, to the same perpendicular, and fall to the ground, as experience testifies. For a stone dropped from a very high tower always falls to the ground at the foot of that tower, that is, of the perpendicular line along which it falls. And from this it might be conjectured, not so absurdly, that there is still some straight motion in nature.

[Margin: Dato Terræ motu, nullus datur motus rectus inTerrâ; & quare ?] *Given the motion of the Earth, there is no straight motion on the Earth; and why?*

But indeed, if, friendly reader, you take the part of a Peripatetic philosopher and acknowledge the Earth as the centre of the universe, I do not wish on this occasion to go down into the arena with you over this matter; rather, I will gladly yield to your opinion, since that very point detracts nothing whatever from our business with the comets. But if you confess yourself a Copernican, professing the daily and the annual motion of the Earth, I say that to you I de- monstrate that no straight motion at all can ever be given, even here on the Earth, except in one single place of the Earth, namely under the poles themselves.

[Margin: Terra circa axem movetur.] *The Earth is moved around its axis.*

For, since the Earth revolves around its axis, everything that is situated on it and adheres to it is also moved around in a circle with equal speed; and from this, too, everything falling, or whatever is thrown, carried forward, or propelled and thrust out, acquires a similar impetus, or impressed motion, toward the same region toward which the Earth is moved, namely toward the east.

[Margin: Lapides quâ ratione de turri decidant, dato motu Telluris diurno.] *How stones fall from a tower, given the daily motion of the Earth.*

Therefore, of necessity, stones too that at first rest on a very high tower are moved together with the tower itself and the Earth as these revolve, so that afterwards, when these stones are left to themselves [ſpontis ſuæ facti] and let go freely without any force, they retain this motion imparted to them, and cannot fall to the foot of that tower otherwise than along a parabolic line: like that stone which glides down from the mast of a ship driven on a very swift course.

In this way, then, and along this course, all things are carried that are directed upward along the perpendicular. But things falling to the surface of the Earth do not universally keep the same section of the parabola, equally obtuse or pointed, as it were: just as happens with things thrown at different elevations.

[Margin: Motus Terræ diurnus circa Polos penè nullus eſt; circa verò Æquatorem velociſſimus.] *The daily motion of the Earth around the poles is almost nil; but around the equator it is swiftest.*

For the daily motion of the Earth is not the same and equal in every place on the Earth [Terrarum]. But you rightly ask where this comes from? Namely from this: that around the equator this motion is swifter than in other places farther from the equator. Under each pole, however, this daily motion vanishes, so that for this reason, under the equator, the section of that parabola of falling things, or of projectiles, is much more obtuse, that is, of a more obtuse cone, than in any other place on the Earth. Therefore, the farther the places where this parabolic motion is carried out are removed from the equator, the more acute is also the section, or cone, from which that parabolic line is derived. And so under the poles themselves, where in reality no whirling motion exists (for the poles always rest in a sphere that is turned around), the parabolic motion is entirely extinguished, and only the rectilinear motion remains; and even if this is not actually produced there, anyone will at least be able to imagine it.

[Margin: Perforatâ Terrâ ad centrum uſq;, quâ ratione lapides deciderent.] *If the Earth were bored through to the centre, how stones would fall.*

For this reason, if the Earth could be bored through from one pole to the other, and a stone slid down as far as the centre, only in this one place of the Earth [Telluris] would this motion or fall take place in a straight line. But if the Earth were dug through under the equator, a stone let down from the surface would trace not only a parabolic line but at the same time a plane helix; and in every other place, *a solid helix described on the surface of an isosceles cone, whose base is the parallel from which the descent begins, and whose vertex is the very centre of the Earth*: as the most ingenious geometer D. Fermatius [Fermat] demonstrates in Mersenne, *Ballist.*, proposition 18, corollary 2.

But so that we do not seem, with these most delightful speculations and most beautiful contemplations, to stray almost too far outside the circuit of our purpose, and to abandon what we have undertaken to treat, let us break them off, however many things remain to be brought forward about them.

[Margin: Nonniſi in unico Terræ loco datur motus rectus.] *Only in one place of the Earth is there a straight motion.*

Let it suffice to have understood that it is not altogether foreign that a similar parabolic motion likewise on the Earth, around terrestrial things, in things shot, thrown, falling, or set in motion in any other way, by an impressed motion, whether the projectile together with the thrower, or mover, or also the projectile on- ly is moved, in all cases, without distinction, and that no other can be given; except in one definite case, namely under the very poles of the Earth, as we have maintained above.

[Margin: Comctæ [recte: Cometæ] in nullâ aliâ, quàm parabolicâ moventur lineâ.] *Comets move in no other line than a parabolic one.*

Finally, leaving these terrestrial matters behind, let us fly away from here and make for the aether again, so that we may return to the comets, and above

all demonstrate for the present somewhat more accurately what we touched on briefly above, on page 659: namely, that comets begin and carry out their motion neither in an entirely straight line, nor in any other than a partly curved one, and indeed a parabolic one. For in the aether the case is almost the same with all of them (in its own way, however) as with things thrown and set in motion in the air, as will soon become known more fully and more clearly.

[Margin: Motus Cometarum & ProjectiliumTerreſtrium inter ſe comparantur.] *The motions of comets and of terrestrial projectiles are compared with each other.*

On this account let us now draw a comparison, for the sake of better understanding, between the motion of progression of terrestrial projectiles and the motion of progression of comets, showing how close a bond joins the two motions to each other, and that they rest on entirely the same reasons, each, however, according to its own particular propensity, implanted by nature. Namely, that a comet, through eternal causes flowing from necessity, is moved and carried across entirely along a parabolic line, just like a ball shot from a cannon, or anything else propelled by a power, or an extrinsic motion.

First: just as a little ball from a bombard, or a stone from a sling (or all the other projectiles, which I would wish to be included with these likewise), are moved, swung, or propelled in some definite medium, namely the air, so in a like way are comets too in the aether. The aether differs from the air only in this, as we have already touched on several times, that it is far purer; for the rest, however fluid and subtle in the highest degree it may be, it nonetheless possesses a certain opacity of its own, and a body suited to it.

Second: a little ball leaving a bombard claims for itself a twofold motion. One is violent, or an impressed impetus, arising from the nitrous powder; the other is natural, that is, its inborn gravity, or a certain appetency, by whose instinct it is carried, or slides down, toward the Earth, as toward its whole (of which the ball is a definite part).

[Margin: Cometæ duos præcipuos exercent motus, alterum extrinſecum, ſeu violentum; alterum intrinſecum ſive naturalem.] *Comets exert two principal motions: one extrinsic, or violent; the other intrinsic, or natural.*

In an entirely similar way, comets too maintain two principal motions. One of these is extrinsic and, as it were, violent, and proceeds from the whirling of the atmosphere. By means of it an impetus is impressed on the comet (while it goes out of the atmosphere, leaves it, and is restored to its own control [ſuæ ſpontis redditur]), and a force is imparted to it of moving itself further, and indeed along the tangent, or a straight line, unless some other impeding cause intervenes. The other, however, is likewise natural and intrinsic: not, indeed, because I attribute gravity to comets equally with terrestrial things, but because another appetency, not altogether unlike this one, belongs to them, from which all comets toward the Sun, as the centre of the world, and toward the orbs of the planets, as the peripheries of that centre: by the instinct of this propensity they present and turn one side of the comets, flat and spread out, toward the Sun,

as toward the centre of the universe, at every time without exception, from an inborn force and power (which does not lack fitting reasons, partly already discovered, partly to be added below), and the other side, again, directly toward the spheres of the orbs of the planets; and in this direction they persistently maintain themselves from then on: namely when the comets at- mosphere, go out free, or are expelled from it into the aether, are ejected, and become their own masters; of which whole aether, namely, the Sun is the centre, and the orbs of the planets, as it were, the surfaces of that centre. This motion, I say, is likewise natural and intrinsic, and is elsewhere called by us the inclination of the cometary disc.

[Margin: Prout acus magnetica perpetuò Septentrionem, ſic alterutrum latus planum diſci Cometici Solem reſpicit.] *As the magnetic needle perpetually [faces] the north, so one or the other flat side of the cometary disc faces the Sun.*

And this appetency, or this motion, by virtue of which comets perpetually incline with one flat side toward the centre of the universe and with the opposite side toward the orbs of the planets, very nearly imitates the magnetic needle. The needle unceasingly turns, stretches out and directs one point toward Aquilo [the north] and the other toward Auster [the south]; and in whatever direction you turn the box in which it is enclosed, it nevertheless constantly keeps the same direction. We also see a similar propensity toward the magnet in any small piece of iron: wherever the magnet is moved, the iron nevertheless always follows and accompanies it with the same face, unmoved.

[Margin: Id quod gravitas in globo exploſo, vel projecto, idem inclinatio diſci in Cometis operatur.] *What gravity [does] in a ball fired or thrown, the inclination of the disc effects the same in comets.*

By reason of these motions there is produced both that parabolic line which is conspicuous in the throwing and firing of balls (since gravity continually gains strength while, on the contrary, the impressed impetus is continually weakened, so that it describes not an entirely straight line but one bent in a certain way, as we indicated more fully a little before), and the one met with in the trajections of comets.

[Margin: Cometa, ex inclinatione diſci, in directum omninò progredi haud poteſt; ſed partim à ſuſcepto tramite deflectitur, tum motus ejus retardatur, ac deniq; penitùs ſiſtitur.] *A comet, because of the inclination of its disc, cannot advance entirely in a straight line; rather, it is partly deflected from the path it has taken up, then its motion is retarded, and finally it is stopped altogether.*

For as gravity does in the former, so in the latter the inclination of the disc, or the motion of appetency of the comets, brings it about that one or the other of their flattened faces is perpetually turned and stretched out toward the Sun at a right angle; so that a comet is by no means able to advance straight forward, entirely directly, in that straight path, as indeed ought otherwise to happen according to the first impetus and the impressed motion. For the comet successively bends its disc one way and then another, namely by exposing a greater and greater part of the disc, or of its extended face, toward the course

in which the comet was thrown or propelled. Therefore it is not only retarded and checked more and more in its course, but is also gradually turned aside and thrown off, in part, from the very trace it had taken up and seized, which it would have kept entirely straight had that impeding cause been removed.

[Margin: Deviatio in omnibus Cometis,circa finem, ad Solem tendit.] *In all comets the deviation tends toward the Sun near the end.*

This deviation, however (note this well, since no mention at all has yet been made of this matter), finally, or at the end of the cometary journey, always tends and inclines toward the Sun; and indeed in all comets, as all observations attest. Namely, the deviation tends toward the Sun from the time when the comet has already passed the perpendicular let fall from the Sun onto the trace, and has left it behind; but the contrary happens while it is making its way toward the perpendicular.

[Margin: Nonnunquam tamen in primo Cometarũ exortu, d[[c/e]]viatio in contrarium, à Sole nimirùm fertur.] *Sometimes, however, at the first rising of comets, the deviation [?] is carried the contrary way, namely away from the Sun.*

For at the beginning, if this very thing could be observed so accurately (which, however, is scarcely granted), it would be plainly established, as evident reasons are also not lacking, that in some comets, namely (those which complete and run through an equal interval on either side of the Sun, or of that perpendicular drawn from the Sun to the trace; of these, however, more later), the deviation in fact takes place away from the Sun: just as in the later part of the trajectory that deviation is found to be toward the Sun.

[Margin: An motus Cometarum in axe, an vero in fundo parabolæ initium ducat ?] *Whether the motion of comets takes its beginning at the axis, or rather at the bottom of the parabola?*

In this way, therefore, the parabolic section is described by the cometary motion in such a way that the line does not take its beginning exactly at the vertex, or about the axis of the parabola, but at the bottom of the parabola, namely at the extremity of the ordinate [lineæ ordinatim applicatæ], as happens with balls that are fired: if, namely, the comet, on either side of the Sun, for an equally long time were seen, and we were permitted to observe exactly both its genuine rising and its end.

[Margin: Non ſemper integram parabolæ ſectionem Cometæ motu ſuo deſcribere videntur.] *Comets do not always seem to describe an entire section of the parabola by their motion.*

But if the comet (as usually happens) were to come into our view for the first time in the middle of its journey, when it has already almost completed half of its trajectory, near the Sun, where its radius falls perpendicularly onto the trajectory (a place I call the middle way) and the diameter of the comet's head mostly appears greatest, at its nearer distance from the Earth; or if right at the beginning it were to come forth from the atmosphere at a right angle with respect to the Sun: then, I say, the section of that parabola would take its beginning only from its vertex, and would thus be found halved. There is,

however, no point in saying anything about this on this occasion. Let us rather speak for the present about that cometary course which might happen to be observed from its very beginning, when the comet goes out of the atmosphere into the open aether: for example, coming from the atmosphere of Saturn, it would cross the orbs of the remaining planets and of the Sun, at an acute angle of the solar ray and of the trajectory, until it returned again to the orb of Saturn, from which it arose. And so it is again clear that a ball, and every thrown thing, marks out a parabolic line by its motion in a way not different (as I have already set out at greater length above) from that in which comets [mark out] the same line by their trajection, so that in this point too the cometary trajection agrees entirely with the motion of projectiles.

[Margin: Cometa Solaris, ut ſemiparabolam deſcriberet, ſic in vertice parabolæ primum initium duceret.] *A solar comet, as it would describe a semiparabola, so would take its first beginning at the vertex of the parabola.*

But if there were a solar comet, which had taken its birth entirely from the Sun's atmosphere, or one which, right at its first rising, were ejected from the atmosphere of some other planet exactly along the perpendicular with respect to the Sun and the trajectory, then its course, I say, if I am to rely on my conjectures, would be far different: for it would make the beginning of its trajection at the vertex of the parabola. But this is not the place to go through everything about this halved section of the parabolic line, since it will be duly examined in its own place.

[Margin: Diſcrimen inter projectorum & Cometarũ motum parabolicum.] *The difference between the parabolic motion of projectiles and that of comets.*

This difference, however, would exist between projectiles and comets, with nature not opposing it and reasons not resisting it (of which, however, more clearly later): that the vertex of the parabola described by comets would by no means always fall below this line of direction, as it does with balls fired from a cannon aimed along a course parallel to the horizon (where, namely, the line of direction is equidistant from the Earth's surface), but would not rarely fall above it as well.

[Margin: Quando infra, quando rurſùs ſupra lineam directionis vertex parabolæ deſcriptæ à Cometis incidat.] *When the vertex of the parabola described by comets falls below the line of direction, and when, again, above it.*

And indeed above, namely at the time when an entire section of the parabola would be described by the comet, where the vertex would fall at the middle of the course; but below, when the comet would begin its motion around the middle of its path, at the vertex of the parabola, namely at a right angle (as happens more often, and rarely otherwise, since comets scarcely ever come into our sight sooner than when they have traversed half the interval of their course); and then, I say, the section of the parabola proceeds below the line of direction, as is the usual experience with thrown balls.

Where this discrepancy draws its origin from, however, is not so easy to say; but the matter is explained and demonstrated far more readily and more clearly

by a certain diagram, together with all the things pertaining to it here which were only lightly touched on before.

[Margin: In quibus exploſa & Cometæ ratio motus velocitatis diſcrepent.] *In what respects things fired and comets differ: the reckoning of the velocity of motion.*

But before we come to that, it is pertinent to point out some things in which fired balls disagree with comets in their trajection in respect of the velocity of motion [ratione motus velocitatis]. First: in thrown balls, from the origin, always the motion of th- em is stronger and more direct; but in its progress it is gradually weakened, namely toward the vertex of the parabola, where the natural motion, or [the motion] of gravity, begins to prevail; there its force is almost everywhere at its weakest (but [this holds] in those motions in which an entire section of the parabola is given).

[Margin: Motus exploſorum ſub inclinatione elevatiori aliquá,initio & ultimò velocior eſt,quã in medio.] *The motion of fired [balls] at some higher inclination is swifter at the beginning and at the end than in the middle.*

Afterwards that impetus of the ball, as it descends, successively and little by little acquires greater force and grows, so that this ball is far swifter in the first and the last [part of its] progress than in the middle: namely when throws and firings are carried out at some higher elevation, where the whole section of the parabola takes place.

[Margin: Motus verò Cometarum, ubi radius ex Sole ad perpendiculum incidit, celerior eſt.] *But the motion of comets is swifter where the radius from the Sun falls perpendicularly.*

In the trajections of comets, however, the matter is far otherwise: namely when a comet breaks out of its first atmosphere and sets up its motion in such a way that it begins its course at the bottom of the parabola (where its whole section is marked). For at the entry of the trajection their motion is not the swiftest of all, nor at the extremity; but in that case it is always [swiftest] about the middle way of the journey, at the vertex of the parabola: that is, to state my meaning correctly, where the radius from the centre of the Sun is drawn perpendicularly to the trajectory. There, I say, the motion is swiftest; and wherever the comet takes the beginning of its course, whether with respect to the parabola, or with respect to us, or of its first appearance, makes no difference at all: according to our Theorem XVI on the trajection of comets, set out on p. 640 of this Book.

[Margin: Quænam hujus rei genuina ſit ratio.] *What the genuine reason for this is.*

Therefore the further the comet is removed from that perpendicular line, whether on this side or beyond it, the slower its motion is; although the extrinsic motion and the impressed impetus given to the comet from the very beginning is in fact entirely uniform, that is, when each and every impediment is removed, as we proved above. That the course of comets is the most rapid of all in the middle of the line of their journey, about the vertex of the parabola, arises indeed from nowhere else than from their intrinsic motion, or from the motion

of inclination of the disc. At its prompting [the comet] continually exposes one flat face perpendicularly toward the Sun, and the other, opposite face, in a similar turning, toward the orbs of the planets; so that in this way the comet's disc perpetually forms one angle after another with the trace, or rather with the trajectory, and hence the radius drawn from the Sun to the centre of the comet always varies with respect to the trajectory.

[Margin: Quò angulus radii Solaris in Cometis cum Trajectoriâ acutior & obtuſior eſt, eò Cometa tardior, vel velocior exiſtit.] *As the angle of the solar radius with the trajectory in comets is more acute and more obtuse, so the comet is slower or swifter.*

Hence, the further that radius falls onto the trajectory from the point of the perpendicular from the Sun (which radius is always perpendicular at the vertex of the cone), the more acute the angle is; and the nearer [it falls] to the perpendicular, the more obtuse [the angle is], and the more it tends toward 90°. But where that angle of the solar radius with the trajectory is more acute, there by inevitable necessity the motion is also slower; again, the more nearly [the radius] falls at a right angle, the swifter the comet becomes, and vice versa.

Although these things have been set out by us clearly and fully enough, we nevertheless think that they will scarcely be grasped so very easily by each and every one, much less that the reasons will be drawn out at once [è veſtigio]. Therefore, for the sake of better understanding, let us now explain and demonstrate by a diagram all the things that we put forward a little before.

[Margin: Schemate declaratur, quomodo motus Cometarum peragatur in lineâ] *It is shown by a diagram how the motion of comets is carried out in a line*

In the following diagram let S be the Sun, [and] the outer circle the orb of some planet, drawn from its centre, namely the Sun; the remaining orbs of the planets are parallel to it. At number 1, for example, let there be the atmosphere of Saturn, from which fresh cometary matter first flowed out into the adjacent atmosphere.

[Margin: parabolicâ; tũ quomodo inclinatio diſci indeſinenter varietur.] *[that is] parabolic; then how the inclination of the disc varies unceasingly.*

Once this matter has been sufficiently condensed and made fit for motion, it ascends more and more, and indeed at first, of itself, with a motion that is in a way straight. But since the atmosphere, together with the body of Saturn, is carried round in a fixed periodic whirling, that ascending matter acquires greater and greater force to move itself further on and to remove itself from its body, or centre, toward the periphery of the vaporous orb. When it finally reaches that point, it is ejected, as it were, out of [the atmosphere] into the free aether, and indeed with a parabolic motion along the line V X Y Q P; although that expulsion or throw ought in fact to take place along the straight line, or tangent, E D C B A K N P, in the usual way: if, that is, no obstacle and no deviation intervened to lead the comet away from that straight line of direction.

[Margin: Motus recentis materiæ Cometicæ in Atmoſphærâ ſpiralis eſt, inſtar lineæ helicæ.] *The motion of fresh cometary matter in the atmosphere is spiral, like a helical line.*

Nevertheless, the genuine motion of the cometary matter, ascending from the body of the planet right up to the periphery of the atmosphere, is not entirely straight, if the natural motion belonging to that matter, and the expelling force inherent in the planet, are weighed somewhat more accurately together with the gyratory motion of the atmosphere. And then, I say, this motion is neither wholly straight nor absolutely circular, but compounded of both; in such a way that this fresh cometary matter, supposing it remained in the atmosphere for at least one period of revolution, would describe a simple coiled line [lineam involutam], or a spiral, or a shell-shaped [line], in the manner of a helical line, as can be seen at number 1.

[Margin: Nonnunquam etiam lineam involutam multiplicem deſcribit.] *Sometimes it also describes a multiple coiled line.*

But if that cometary matter were too sluggish to be carried down to the outermost limits of the atmosphere within the interval of one periodic revolution, and it happened instead to linger in the atmosphere through many turns of revolution (and I would readily grant that this can also happen fairly often), then, believe me, the motion of that matter would mark out a multiple coiled line, according to the revolution of the atmosphere repeated many times: and indeed a regular or an irregular one, according as the matter, thinner or denser, were then more suited to motion, and departed from its planet now more slowly, now more swiftly. A multiple spiral line of this kind we have drawn, approximately, at Num. 2.

[Margin: Linea illa ſpiralis, an in omnibusCometis ſit planè eadẽ.] *Whether that spiral line is entirely the same in all comets.*

I add that if we weigh this motion a little more deeply still, we come upon several further differences in that line along which the cometary matter [travels] until it goes out of the atmosphere. For an entirely different spiral line would result when the motion tended toward the equator of its orb, to say nothing of the case where the atmospheres were of different capacity. For every planet, just as it revolves in a fixed period, so also recognizes its own poles and its own equator. Likewise another, shell-shaped line, or else a helix, would emerge if at any time the matter took and directed its course elsewhere. This can certainly be readily demonstrated and perceived from any artificial globe, celestial, terrestrial and armillary. For the degrees of the greatest circles subtend greater spaces than those of the lesser [circles]: in the tropic circles, as is plain, the spaces of the degrees are far more compressed than on the equator; again, in the tropic circles they are wider than in the Arctic and Antarctic [circles], and so on, right up to either pole.

[Margin: Vnde hic vel ille Cometa motu concitatior eſt.] *From what cause this or that comet is more rapid in its motion.*

Hence under the equator one degree contains more miles than in the tropics and the other subordinate lesser circles.

Diagram. A full-page engraved plate with no text on the page, captioned *Fig. GG.* and signed by the author as engraver. At the centre left stands the Sun, from which straight rays fan out to the right across concentric arcs of planetary orbs, labelled from the inside outward as the orb of Venus, the great orb, the orb of Mars, the orb of Jupiter and the orb of Saturn. In the main figure a straight line and a bold curved line both start at P at the upper left and run down to the right to a small circle beside the orb of Saturn, which is marked with the sign of Saturn and holds a small spiral. The straight line, labelled as the line of direction, carries the lettered points O to H and A to E, each with a short dotted line across it marked u at one end and t at the other, and a at the crossing for the four lowest points. The bold curved line, labelled as the parabolic trajectory of the comet, carries short cross-strokes, the lower ones lettered. A ray from the Sun, labelled as a perpendicular line, rises toward the line of direction. Below, a bold curved line labelled as the hyperbolic trajectory of the comet runs from the far left down to the right past the Sun, with lettered points marked u and t. Three subsidiary figures stand beside the main one: at the upper right, a large circle holding a spiral of one turn, marked J; at the lower right, a spiral of several turns round the sign of Jupiter, numbered 2; and at the left, a line with short cross-strokes, labelled as a trajectory, beside a thin line of direction, ending beside the figure 3. At the upper right two further lines, labelled as the parabolic trajectory of the comet and the line of direction, descend from the top of the plate to the circle beside Saturn. The labels engraved on the plate:

- J (inside the large circle at the upper right, above its spiral).
- *Trajectoria … Cometæ … Parabolica.* (spaced along a line descending from the top of the plate to the circle beside Saturn): Trajectory of the comet, parabolic.
- *Linea … Directionis* (along a second line beside it): Line of direction.
- *Orbis Saturni.* (along the arc of the outer orb, upper middle): The orb of Saturn.
- P (at the upper left, where the straight line and the bold curved line meet).
- O, N, M, L, K, I, H, A, B, C, D, E (the lettered points of the straight line, from upper left to lower right), each with u and t at the ends of its dotted line, and a at the crossing beside B, C, D and E.
- *Linea* (beside H) … *Directionis* (between B and C), along the straight line: Line of direction.
- u, t (at a cross-stroke of the bold curved line level with K).
- *Trajectoria Cometæ Parabolica.* (along the bold curved line): Parabolic trajectory of the comet.
- [?] (a looped letter at the next cross-stroke of the bold curved line, with u and t), Y, X (with u and t), W (at the following cross-strokes); u, t (at the last cross-stroke, beside the circle, which carries no capital).

- J and the sign of Saturn ♄ (inside the circle at the lower end of both lines).
- *Orbis* ♃ and *Orbis* ♂ (along two arcs at the far left): The orb of Jupiter; the orb of Mars.
- *Linea … Directionis.* (along the thin line of the left figure): Line of direction.
- *Trajectoria.* (along the line with cross-strokes of the left figure): Trajectory.
- 3 (beside the lower end of that line).
- *Linea … perpendic.* (along a ray rising from the Sun): Perpendicular line.
- *Sol.* (at the point where the rays meet): The Sun.
- L, K, I, H, A, B, C, D (the lettered points of the hyperbolic line, from upper left to lower right), I to D each with u and t; u, u, t (at the last cross-strokes).
- *Trajectoria Cometæ Hyperbolica.* (along the hyperbolic line, below H): Hyperbolic trajectory of the comet.
- *Orbis Veneris.* (along an inner arc, lower left): The orb of Venus.
- *Orbis Magnus* (along the next arc out): The great orb.
- ♃ and 2 (at the centre of the spiral at the lower right, and beside its inner turns).
- *Fig. GG.* (lower centre-left): Figure GG.
- *Autor ſculpsit.* (lower left): Engraved by the author.

In the same manner and proportion the motion of fresh matter lingering in the atmosphere also takes place. For this motion too is the most rapid and the most vehement of all at the exit from any sphere around the equator, as under a greatest circle; but more sluggish under the lesser circles and spheres, and consequently, at the poles themselves, it is the slowest of all.

[Margin: Prout Cometa hoc vel illo loco Atmoſphæræ primùm exit, eò velocior vel ſegnior eſt.] *According as a comet first goes out at this or that place of the atmosphere, it is swifter or more sluggish.*

Accordingly, the spiral line, or helix, is necessarily in fact one where the cometary matter is carried straight to the equator, and another where it is launched elsewhere [libratur]; and finally another where it is belched out and ejected at the pole of the atmosphere. From this the cause is now plain why cometary matter obtains one motion or impetus after another, now more intense and greater, now more relaxed or smaller: namely, according as it flows out and evaporates from this or that place of the planet, and is driven out from this or that part of the atmosphere with respect to the equator or the lesser circles. Of these things more fully a little later; it is enough to have touched on them now.

[Margin: Circa Æquatorẽ Atmoſphæræ linea conchalis ſemper maxima eſt.] *Around the equator of the atmosphere the shell-shaped line is always greatest.*

Therefore, if the cometary matter, the evaporations or effluvia, were to burst out from the body of the planet around the equator and coagulate, and then were also driven straight on along such a course toward the equator of the atmosphere, then, I say, the line of motion would be a simple coiled line, or a

multiple regular one, according as the atmosphere revolved more frequently in a fixed period. This line would be described as if on the base of a circle, or of a certain truncated cylinder, or of a cone; and there this shell-shaped line would be greatest, since the circle, or base of the cone, is widest.

[Margin: Circa Polum verò Atmoſphæræ helix omnium minima eſt.] *But around the pole of the atmosphere the helix is the smallest of all.*

But when the evaporations ascend at some other place of the atmosphere, then, in the measure that the circles there are smaller, in the same measure the helix too would turn out smaller, and at the pole the smallest of all. That is: the nearer to the pole the shell-shaped line lay, the more coils and bends it would indeed produce, but these would be much tighter than those described around the equator; and so, the nearer to the pole, the more compressed [they would be], and consequently the diameter of the spiral line too would be continually smaller: no differently than if a helix were described on an isosceles cone, or a cylinder.

[Margin: ProjectionesCometarum, quæ in Atmoſphærâ contingunt, diſtinguuntur in horizontales, obliquas & perpendiculares.] *The projections of comets that occur in the atmosphere are divided into horizontal, oblique and perpendicular.*

For the sake of better distinction, these projections that take place in the atmosphere can be divided, or distinguished, into three kinds: namely, into horizontal projections, which [take place] under the equator; into perpendicular ones, which [take place] under the pole itself; and into oblique or inclined ones, which take place in the intermediate places. And these in turn are various, according as the projection is nearer or farther with respect to the equator and the pole.

[Margin: Cometæ, qui circa Æquatorem Atmoſphæræ ejiciuntur, ex iſtâ ratione, ſunt omnium velociſſimi.] *Comets that are ejected around the equator of the atmosphere are, for this reason, the swiftest of all.*

Hence it follows that the matter springing out around the equator is projected as if from a longer sling, or a wider circle; but at the pole (where the rotation is narrower, there consequently also weaker) it is as if a stone were hurled from a narrower channel, compared with a much broader one.

[Margin: An hæc ſpeculatio de motu Cometarum ſpirali de nihilo habenda ſit.] *Whether this speculation on the spiral motion of comets is to be held of no account.*

But (you will say) what good are these subtleties, and to what end are they set out here at such length? Is it not all the same, you will add, whether this motion traces such a spiral line or another, greater or smaller, or no coiled line at all? It is enough to know only this: that the cometary matter, going out of the atmosphere, persists in a constant and continuous motion; so that nothing more remains than that these things alone should be inquired into: whether the motion of comets exists entirely in the straight line of direction, or rather in a parabolic one, and the things that pertain to these? But truly, in my judgment at least, very great- ly does it matter that all these things, each and every one,

be duly investigated and rightly known. And they will certainly turn out to great advantage, no differently from the things that were set out at such length at the beginning of this Book about the rudder of ships and its power and force, and then about how, by its aid, the largest ships, laden with the heaviest cargoes, can be steered in the water and directed every way; although those things likewise seemed to have nothing whatever to do with the matter in hand [ad rhombum].

[Margin: In hâc ſpeculatione, prout in directionibus temonum, plurima arcana de Cometarũ motibus deliteſcunt.] *In this speculation, as in the directing of tillers, very many secrets about the motions of comets lie hidden.*

For on both sides very many secrets about the motion of comets lie hidden, as I shall very soon disclose at greater length.

[Margin: Quâ ratione recens Cometa Atmoſphærâ exeat.] *How a fresh comet goes out of the atmosphere.*

Further, so that we may proceed, it is relevant to know that the cometary matter, whatever of it is fit for motion and sufficiently condensed, is carried along a helical line to the bounds of the atmosphere in such a way that it continually turns one flat face of its disc-shaped body toward the planet from which it arose, and the other in turn toward the concave [side] of the atmosphere. Next, it is relevant to know also that it bursts out of the atmosphere at very nearly that inclination, so that it exposes one side or the other directly to the Sun, and consequently also to the Earth (as is sufficiently clear from the diagram and from what has gone before). But if at the point of exit it does not at once go out of the atmosphere with that same face, it immediately turns itself aside [offlectit] by that inborn, intrinsic power of which we have already spoken above; this is also seen from the preceding figure, under the letter E.

[Margin: Perpendiculum ex Sole ad Cometam cum Trajectoriâ, pleruṇq; acutiorem conſtituit angulum.] *The perpendicular from the Sun to the comet mostly makes a more acute angle with the trajectory.*

It therefore cannot happen otherwise than that the comet's disc t u then makes an acute angle with the trajectory, just as the ray drawn from the Sun to the comet [does] with that same trajectory: that is, when the comet is still very far from the perpendicular falling from the Sun onto its path. Next, the comet ought now indeed to proceed steadily along that straight path E C A L O, etc., which it has once entered, according to the third axiom, given on p. 644: that what is moved has a power of persevering in its motion (since each thing tends to remain in the same state in which it is), that is, in a motion of the same speed and toward the same direction, unless it is hindered, or accelerated, by another motion supervening.

[Margin: Ratione motus inclinationis diſci, qui ad Solem per ſecantem procedit, Cometæ à recto tramite exorbitant atq; nunc tardiores, nunc velociores exiſtunt.] *By reason of the motion of inclination of the disc, which proceeds toward the Sun along the secant, comets depart from the straight path, and are now slower, now swifter.*

Since, therefore, some hindrance intervenes, namely the motion of inclination of the disc, the comet is drawn aside from that straight line of travel, and the result is that it proceeds at this place rather than that with now a slower, now a faster course. For when the line of motion is curved, the impetus is destroyed, and therefore that body begins to move more slowly, namely as a result of those diverse impressions of motion. The motion of comets therefore consists of a twofold motion: one that proceeds straight along the tangent, and another that, from a fixed inclination of the disc, turns itself toward the Sun along the secant.

[Margin: Schemate res dilucidatur.] *The matter is clarified by a diagram.*

For greater clarification, let us set out the comet (as it is sketched in the diagram above), and how it is carried across in its trace, with its face always varied with respect to the line of its course, but unmoved with respect to the Sun, as if perpetually the same. In this drawing we see that at first the diameter of the comet's disc t u forms with the trajectory, for example at E, a far more obtuse [angle], while the ray of the Sun S a forms with the same trajectory a far more acute angle, than at D, C, B. So in the earlier position the comet's disc stands more crosswise, or more obliquely, on the trajectory than in the subsequent places D C B.

[Margin: Decreſcente inclinatione diſci motus Cometarum augetur.] *As the inclination of the disc decreases, the motion of comets increases.*

This inclination of the disc, however, decreases daily, in this example, up to A: because the angle at a, enclosed by the radius of the disc and the trajectory, gradually diminishes, just as the angle at a, comprised by the ray of the Sun S a and the trajectory, successively up to A increases; there the ray falls perpendicularly onto the trajectory, and the comet is always nearer to the Sun. For on the perpendicular the distance is at all times the least, according to Theor. 21, Prop. 19, [Book] I of Euclid, and the corollary of Clavius: *of all straight lines drawn from any point to any straight line whatever, the one that is perpendicular is the least.*

[Margin: VbiCometa Soli propior eſt, ibi velocior eſt.] *Where the comet is nearer to the Sun, there it is swifter.*

In that same place, I now say, it accordingly [eâ ratione] exposes and directs one or the other of its spread-out faces parallel to the course of its trace, or of the trajectory, [the face] which [quàm] it had earlier exposed crosswise; so that at that time the comet advances with its narrower side, or its thickness, straight on toward the parts ahead [in partes adverſas], entirely in accordance with the impressed impetus. But as soon as it moves on further from this place A, toward H I K, it again begins to tilt its disc more and more, and to move itself somewhat further crosswise with respect to the trajectory, so that it may keep the same face, which was also before turned directly toward the Sun, continually toward the Sun, as the centre of the world, and likewise its opposite side toward the orbs of the planets. This, however, could by no means at all happen if it always pressed on its course at one and the same inclination, as is seen at H. Afterwards, however, the further the comet departs from the perpendicular S H, the more

acute that angle a mentioned above, namely the angle of the solar ray and the trajectory, becomes again; that is, the more obliquely the cometary disc cuts the path, at a more nearly right angle [ſub rectiori angulo], as is evident at I K L M N O P.

[Margin: Cùm diſcus Cometæ non perpetuò eundem ſitum ad Trajectoriam conſervet; hinc Cometa in lineâ rectâ motu æquabili nullo modo progreditur.] *Since the comet's disc does not perpetually keep the same position with respect to the trajectory, the comet therefore in no way advances in a straight line with a uniform motion.*

And therefore, since the comet's disc is in no way able always to keep one and the same position, or one and the same inclination, with respect to the trajectory (for by an inborn natural power, as it were a kind of magnetic one, it perpetually turns the face of its disc toward the Sun), it follows from this that the comet cannot continually pursue its course in one and the same path, namely in the straight line, or tangent, in which it took up its motion at its first rise and its exit from the atmosphere. Rather, it is compelled now to quicken, now to slacken its pace, like some disc-shaped body carried across by some motion, whether through water or through air, as may be read at the beginning of this Book IX; and likewise according to those four axioms, very well founded in nature itself, and then demonstrated on p. 571 of this Book IX.

[Margin: Quâ ration[?] corpus difficilius tardiusq́; rursùs quomodo leviùs celeriusq́; commoveatur.] *In what way [?] a body is set in motion with more difficulty and more slowly; again, how it is set in motion more easily and more swiftly.*

The first of these runs as follows: that every body, the greater the resistance it is subject to, the more laboriously and slowly it moves; conversely, the less [the resistance], the more easily and swiftly. In the third axiom, moreover, it is established that any disc-shaped body whatever, set in motion or propelled straight on toward the parts it faces [in partes obverſas], with its disc upright with respect to the trajectory and with one or the other of its narrower sides, or the thickness of the body, in a parallel course: the more it tilts itself with its disc in its trajection, against the path set before it [adversùs tramitem propoſitum], the more its impetus and motion are hindered and retarded; and at the same time it is drawn aside and deviates more and more from its genuine path, which it would otherwise follow interruptedly [interruptè], and would even be compelled of necessity to follow altogether, if, namely, it kept the flattened sides of its body strictly and constantly parallel to the trajectory.

[Margin: Vnde motus diſceorum corporum acceleretur,ac retardetur.] *Why the motion of disc-shaped bodies is accelerated, and retarded.*

Conversely, [the axiom establishes] that if a disc-shaped body is moved forward at first with its flat face, but afterwards turns itself aside [offlectit] with its thinner side toward its course, then the more it does so, the more its motion is accelerated: in so far, namely, as a constant and uniform impetus is given.

[Margin: Cometæ, ratione motûs,amulan ur motum diſceorum commotorum corporum.] *Comets, by reason of their motion, emulate the motion of disc-shaped bodies set in motion.*

For these reasons, and according to these laws, which agree with nature, all comets too truly and really deviate from their straight path, so that by their trajectory they necessarily describe a parabolic line, and on both sides of the perpendicular ray drawn from the Sun to the trajectory they move more sluggishly. Moreover, the more remote they are from that perpendicular, the slower still they are; but they are found to be the swiftest of all at the perpendicular itself, where, namely, the comet's disc is parallel to the trajectory. But let us clarify this very point still more clearly by the preceding diagram, showing how it can happen; although I do not doubt that the attentive reader has already well perceived and understood all this, especially if the reader has properly weighed and balanced in mind what was said at the beginning about the motion of some disc-shaped body, and likewise about the direction of some arrow. Nevertheless, so that there may be no one, even among the rest, who has read this or that only in passing and while going over it cursorily, who does not rightly understand the matter, I did not want to fail this task as well, and at the same time to bring to mind the things that have been put off until now.

[Margin: Schemate motus Cometarum dilucidatur.] *The motion of comets is clarified by a diagram.*

That the comet, at first going out of the atmosphere at E, is swifter up to A, the perpendicular of the Sun, has this as its chief reason: that the comet's disc there, standing on the trajectory more upright, at an almost right angle, passes through a larger part of the aether than around D, a place somewhat nearer to the perpendicular, where the disc-shaped cometary body, already somewhat more obliquely, cuts the way of its course at a more acute angle; and again, that at D it swims through more aether than at C, and so on in sequence up to A, where the angle at the comet, comprised by the disc and the trajectory, vanishes entirely, and the spread-out sides of the phenomenon proceed parallel to the path, its thinner side, namely, being turned toward its course.

[Margin: Quâ Trajectoriæ parte, Cometæ ſemper velociores exiſtant.] *In which part of the trajectory comets are always swifter.*

In that same place, I now say, since the comet passes through and beats its way through the smallest part of the aether of all, it is carried across more easily, and consequently also moves more swiftly, according to those earlier [points] on p. 571.

[Margin: Quare motus eorum creſcat, rurſuſq; decreſcat.] *Why their motion increases, and decreases again.*

In the same way and in the same proportion, from the perpendicular A S to the comet's last appearance, its motion continually decreases, just as it had increased from its first beginning: because the comet's disc turns itself aside more and more, and passes crosswise over the line of travel, and the angle at the comet, enclosed by the disc and the trajectory, becomes more nearly right.

Accordingly, the further the comet is removed from the perpendicular, the more aether it is compelled to pass through, so much so that it can likewise be moved with more difficulty and more slowly. That the comet passes through a larger space of aether at the beginning and at the end is plain to see, especially from what has been said here and there, and from what is now to be added.

[Margin: Demonſtratio valdè evidens.] *A very evident demonstration.*

Imagine for yourself two [lines], parallel along [quà] the trajectory, drawn at any body of the comet you please, E D C B A, etc., so far that they touch the cometary disc at *t* and *u*. From these you will at once see that near E and P those parallel lines are farther removed from each other than near B and I, but that at A they are joined as closely as possible: for here those parallel lines advance entirely together with the disc of the phenomenon, in a parallel course, and do not spread over a larger space than the breadth, or the thickness, of the body occupies. By parallels that are more remote, however, and spread further apart from each other, a greater and ampler space of aether is certainly comprised than by narrower and more confined ones. And therefore also in the earlier position, broad- er place, namely, a greater resistance [renixus] of the aether is met than in the later [position], namely in the narrower place, where a far smaller quantity of aether stands in the way. Therefore, where the resistance is greater, there the motion too is more sluggish; again, where the counter-pressure [obnixus] is smaller, there the motion is also swifter. Finally, since at A the struggle [reluctatio] met with is the least of all, for that reason the motion in that same place is also the swiftest, more than in any other place, according to Axiom I and III brought forward above: which was to be demonstrated.

[Margin: De commotione flabelli.] *On setting a fan in motion.*

For the rest, this too is easily proved with any spread-out and flattened body, such as an open fan: namely, if you set the air in motion with its face widened, you will raise a more vehement wind, or breeze, than if you strike the air with its more compressed side, or its thickness. Conversely, however, the more the fan is extended and unfolded, and the more wind [flaminis] it produces, the more laboriously it is itself set in motion; on the other hand, the more it is compressed, and the less breeze it stirs up, the more readily and swiftly it is drawn forward and this way [prorsùm horsùm] by the hand: as anyone can easily test.

[Margin: De motu orbis.] *On the motion of a quoit.*

In the same way a quoit [orbis] too, when it is thrown crosswise with respect to the disc of its body, namely against the motion of its impetus, is certainly carried much more slowly than if it is propelled with its disc upright, its thickness turned toward its course. For this reason boys throw their play quoits [orbes luſorias] in the latter way just mentioned, with their thinner sides directed forward. No less, you will plunge a plank [aſſerem] or a sawn board [aſſem ſectilem], flat on both sides, into the water with greater labour with its side extended than if you first put its thinner side and its thickness into the water; and indeed with all the more difficulty, the broader the plank is.

[Margin: De Navium motu.] *On the motion of ships.*

Similarly, vessels sitting on the water with one side or the other tilted are moved with more difficulty and more slowly, even given one and the same wind, or impetus of the wind, than if the prow is set toward the course and the keel points toward the bottom. And so that sailors may sail [vela … faciant] the more easily and swiftly, they build the prow and the keel the sharper, to say nothing of the rest.

[Margin: Æther, ut aër, infert commotis corporibus aliqualem renixum.] *The aether, like the air, brings some resistance to bodies set in motion.*

All of this is clearer than daylight, so that it needs no fuller demonstration. For the aether, as has already been impressed quite often, although it is a most subtle matter, is nevertheless only the purest air, displaying in its own way a definite body; moreover, although it is most fluid, so that the easiest passage is given to any body in it, much easier indeed than in our sublunary air, it nonetheless brings some resistance and counter-struggle [obluctationem], on account of its own body, to a body carried across it.

[Margin: Non ſolùm, ex inclinatione diſci & angulo radii Solis & Trajectoriæ ad Cometam; ſed etiam ex augmentatione & diminutione motus Cometarum variatur.] *The motion of comets varies not only from the inclination of the disc and the angle of the Sun's ray and the trajectory at the comet, but also from augmentation and diminution.*

From these things, first, it becomes evident from what cause and when comets are slower and swifter: namely from the differing inclination of the disc, and the varying angle of the Sun's ray and the trajectory; which we had set ourselves to demonstrate. Yet in addition another cause joins that inclination of the disc, one which, as we have said, retards and accelerates the motion more and more in the same way: namely, to put it briefly, from the augmentation or diminution, and likewise the rarefaction and condensation, of the cometary body.

[Margin: Cometæ, quando apparent, quà diametrū, minores, pleruńq; majores reverà ſunt.] *Comets, when they appear smaller as to their diameter, are for the most part larger in reality.*

For you have learned in its place, especially in Book VII, p. 383, that comets are at first generated gradually and successively, and take their beginnings, from some very thin matter, to which afterwards more and more adheres from day to day and grows on, so that it then grows out into a very great mass; but while that more diluted matter is gradually condensed and acquires its nuclei, up to its maturity, that mass, as it is packed together, so is compressed, and is in reality dimin- ished, as to body and diameter, although at the beginning and at the end the comet sometimes appears smaller: as we fully established in the proper place, p. 414 of the same Book, and clearly proved by examples, especially by the comets of the year 1618 and 1652, that the matter is thoroughly so.

[Margin: Cometæ, quando ſolidiores, ſimul reverà minores ſunt.] *Comets, when they are more solid, are at the same time smaller in reality.*

But after the comet has attained its maturity, that cometary matter begins gradually to be dissolved and attenuated, to the extent that it then at the same time expands itself again, and in the course of time that mass is increased not a little by this dilatation and rarefaction, relative to the constitution of the cometary body when it stands in its strength, namely in the vicinity of the Sun.

[Margin: Ex raritate & denſitate motus Cometarū quoque retardatur, vel acceleratur.] *From rarity and density, too, the motion of comets is retarded or accelerated.*

From this, two new causes arise, on account of which that retardation and acceleration of the motion in comets is furthered still more. The first is this: that, because the cometary matter around the beginning is much rarer than later around its maturity, the body is then less fit for motion than when it is already somewhat denser and more solid. For more solid bodies are fitter for motion than rarer ones.

[Margin: Cometæ denſiores, habiliores ſunt ad motum, quàm rariores.] *Denser comets are more apt for motion than rarer ones.*

There is added something that argues for this as strongly as possible: since the comet's body gradually thickens and is condensed, it is then certainly also more disposed to motion, and moves more swiftly. Conversely, because at the end the matter of comets in turn grows rare and becomes more diluted, it is for this reason also rendered less apt for motion. The second cause, however, is this: that when the cometary matter is resolved and scattered, so that it may return to its place assigned by nature (about which more fully below), the comet's body is then necessarily extended before it is entirely dissipated and goes off into different parts.

[Margin: Tenuiores Cometæ pleruńq; ſunt quà diametrum majores.] *Thinner comets are for the most part larger as to diameter.*

From this it follows that, while the cometary body is made thinner and larger, it is at the same time made less suited to motion. For it is then subject to a far greater resistance, because its disc becomes larger, at the same inclination with respect to the trajectory, as it constantly keeps its flat face toward the Sun.

[Margin: Solidiora corpora capaciora ſunt motus.] *More solid bodies are more capable of motion.*

This retardation, too, is furthered not a little by the rarity and thinness of the body. For wool, or other softer and more porous matter of this kind, is less suited to motion than wood, stones, and denser and more solid matter. Therefore, when the comet has already acquired its due maturity, according to the constitution of its body, its body becomes thinner more and more from day to day, right up to its destruction, and is dilated and extended more and more; and hence it cannot happen otherwise than that the comet is continually retarded more and more, and its course held back.

[Margin: Quare Cometa ab ipſo initio curſu tardior ſit ?] *Why is a comet slower in its course from the very beginning?*

Conversely, however, the comet is always slower in its course from its first rise; but in the course of time its motion is accelerated, for exactly the same reasons: namely, that at the beginning, when it first leaves the atmosphere, its body is thinner and ampler; but afterwards it gradually thickens, is packed together and consolidated, and also in reality becomes smaller as to diameter; so that it becomes swifter daily, until it acquires a fitting strength and passes the perpendicular falling from the Sun onto the trajectory.

[Margin: Motus Cometarum in Trajectoriâ quidem eſt inæqualis, ſed minimè inordinatus.] *The motion of comets in the trajectory is indeed unequal, but by no means disorderly.*

We have therefore stated why the motion of comets, in this or that part of the trajectory, is retarded more or less, especially around the beginning and the end of the appearance, and again, around the middle, where the perpendicular from the Sun falls onto the trace, or the comet, is accelerated; and also that for this reason the true motion of comets is necessarily rendered unequal, yet by no means disorderly, but in the highest degree orderly and pro- portionally, both in accelerating and in retarding. And indeed in this manner: that comets continually intensify their course from their first rise up to the point of the trajectory where the perpendicular falling from the Sun meets it; but from this point A (of the diagram above) right up to their destruction they slacken their course in due proportion.

[Margin: In quibus Cometarum motus à projectorum, vel exploſorum motu differat.] *In what respects the motion of comets differs from the motion of things projected or shot off.*

In this respect, therefore, the motion of comets is entirely different from the one described by balls projected from a cannon, by stones from a sling, from a bow, or by some other force or impetus. For the motion of these is always decreasing, as was asserted above. But in comets that run through the whole section of the parabola, that is (very few of which, however, come into our view, in my opinion, for various reasons, as will perhaps be said more fully in its place), both an increasing and a decreasing motion takes place; just as, from the reasons given above, it cannot happen otherwise.

[Margin: An omnes Cometæ in æquali diſtantiâ à perpendiculo in Trajectoriam ex Sole ducto ſint æq; veloces.] *Whether all comets are equally swift at an equal distance from the perpendicular drawn from the Sun onto the trajectory.*

From this a question arises: in all those comets that trace the whole line of the parabola, and that at their first beginning and at their last appearance are removed by an equal interval from the Sun's perpendicular falling onto the trajectory, is the proportion of the increase and decrease of this proper and true motion at all times exactly the same, or is it rather different? To prove the matter itself of comets by undoubted observations and examples is, I admit, very difficult, since hardly any comet, even among those that have been observed

with more anxious care, has been recorded so accurately from the beginning of the parabolic section right to the end. Nevertheless evident reasons, and reasons moreover very well founded in nature, persuade us to establish firmly that the proportion of the increases and decreases of the proper motion cannot always be similar, and the same at the beginning as at the end of the appearance, not even in one single comet, much less in all.

[Margin: Proportio incrementorum & decrementorum motûs in ſingulis Cometis eſt planè diverſa.] *The proportion of the increases and decreases of the motion is entirely different in individual comets.*

The reason is this: that the matter does not always flow in at the beginning (although at an equal distance from the perpendicular) as copiously as it indeed does at the opposite place of the trajectory, around the exit and destruction, nor is it equally dense. For sometimes denser matter is supplied from the first rise, out of this or that atmosphere, which is nevertheless partly attenuated and dissipated again before it reaches the Sun's perpendicular; at other times a new comet first acquires its due maturity and its strength only when it has already passed the said perpendicular.

[Margin: An Cometæ in mediâ itineris viâ ſemper maximè vigeſcant & floreſcant.] *Whether comets are always at their most vigorous and flourishing midway along their path.*

For comets do not always attain their highest strength in one and the same place of the trajectory, much less around the vertex of the parabola, where they are otherwise at their swiftest. From these anomalies and inequalities, which, all and each of them, neither occur nor are devised so easily, it is easy to gather that such a proportioned equality, or inequality, can never occur in comets; but rather that, from what has been said and from other reasons of this kind, there is some prosthaphaeresis, although for the most part it is so slight that it is scarcely detected by observation.

[Margin: An omnes Cometæ æqualem curſum exerceant; tum quantâ velocitate ferantur.] *Whether all comets run an equal course; and with what speed they are carried.*

From this, moreover, a further question arises: whether all comets, of themselves, like the planets, are driven in their orbs with equal speed, or whether one is swifter or slower than another? Further, how different are their speeds? And how much space do they traverse in one day when they are at their most rapid of all? But let us put off this question for now, until from the earlier diagram clear- ly we have first deduced, as we promised, in what way a comet swerves from a straight track and with its motion describes a line that is partly curved, and indeed parabolic, and other matters of that kind bearing on this subject.

[Margin: Cometæ non omnino rectà trajiciunt, ſed ex parte exorbitant.] *Comets do not pass across entirely straight, but partly swerve from their track.*

That comets, by some fixed law, deviate somewhat from the straight line of their route, just like their motion, which at different times is now accelerated more and now retarded, is indeed clearly inferred from the third Axiom set

out on p. 571. But so that you may grasp everything more clearly and more correctly, kind reader, we shall elucidate and demonstrate these things with the preceding drawing.

[Margin: Quomodo & quando Cometæ prorsùs in directum progrediantur.] *How and when comets advance entirely in a straight line.*

You have no doubt understood well enough from what was said above in various places that if the cometary body ever came forth from the atmosphere in such a way that it presented its thinner side, or the thickness of its body, to the front, according to the impetus of its course, and its flattened sides parallel to the run of the trajectory, and if, further, it persevered constantly in such a position in its course right up to its exit, then the motion of the comet would of necessity be always entirely straight, in the direction in which the first impetus had directed it at the beginning: like some vessel driven by a following wind, whose rudder was directed along the length of the said vessel and the course of the river.

[Margin: Vnde curſus Cometarum incurvetur.] *Why the course of comets is curved.*

But since a comet can in no way advance continuously with its two sides spread out and stretched along the run of the trajectory, but must instead be inclined successively more and more with respect to its disc, namely with one or other of its flattened faces toward the Sun, so that it presents its disc to the Sun at right angles, for the reasons brought forward in their place, the angle of inclination therefore continually varies, and becomes the more acute the nearer it approaches the perpendicular drawn out from the Sun onto the trajectory, until under the perpendicular ray itself this angle, namely the one the disc makes with the trajectory, vanishes entirely. Thus, finally, the motion of comets can by no means be entirely straight in its track, but is necessarily curved somewhat.

[Margin: Schemate commonſtratur, quod cometa à recto tramite neceſſariò deflectere oporteat.] *It is shown by the diagram that a comet must necessarily deflect from a straight track.*

This comes about as follows. When, for example, the comet at its first exit from the atmosphere stands at E, where it then sits on the trajectory obliquely and crosswise with its disc, so that it faces the Sun directly, and thus consequently also the Earth and the remaining orbs of the planets, namely at a right angle, and tries to pass across from E toward D in a straight line, then, I say, it is necessarily compelled to deflect from that straight course, and indeed upward at that place, namely toward where the thinner side of the comet, *u*, points. For the aether in that part of the heavens cannot resist or strive against that body so much, but grants it an easier passage. For such is the ordinance of Nature that bodies are moved with the motion by which they can more easily be moved: just like a ship set moving in some rapid river, which, if it were propelled along the run of the river at some inclination, in a crosswise position, would then

necessarily also be thrown partly off the straight track toward where the prow of the vessel pointed.

[Margin: Aliquando etiam Cometa prorsùs rectà trajicit; atq; tum ſemper velocior eſt.] *Sometimes, too, a comet passes across entirely straight; and then it is always swifter.*

And so the comet, in the same way, is partly turned aside from the straight route it had undertaken, namely toward W, instead of coming to stand at D, as it would have had to when, namely, the comet advanced with its sides spread out either parallel to the trajectory or crosswise at a normal angle; in this position, and also in that other one, the comet by no means deflects from the straight line, no differently than a vessel which, if it glided downstream entirely crosswise at a right angle, would, entirely straight, fol- low the path; with this difference, however, both in the trajection of hairy stars and in that of vessels: that in a parallel position and run the motion is much swifter and more rapid than in a normal course, when bodies are driven crosswise. This accords with the first Axiom, noted at the beginning of this Book: Any body, the greater the resistance it is exposed to, is moved the more laboriously and slowly; conversely, the less resistance a thing is subjected to, the more readily and swiftly it is carried. So, departing more and more from W toward X, the comet indeed gradually begins to turn itself toward the tangent, or the first impetus, that is, the course it had undertaken; but at the same time it departs all the more upward from that trace E B H, and indeed into that part of the aether toward which the thinner side of the comet, *u*, then inclines: because of the easier passage through the aether, and also because the impressed motion from behind can propel the comet forward more, and directly.

[Margin: Quando minùs; rursùs quando magis Cometæ à ſuſcepto itinere deviant.] *When comets deviate less, and again when more, from the route they have undertaken.*

For this reason the comet not only becomes successively swifter, but is also compelled to deflect from the straight track it entered on at the beginning, according to that Axiom common to all disc-shaped bodies: The more directly bodies present one or other of their flattened faces to their course, that is, the nearer they come to a right angle with respect to the trajectory, the less they deviate; conversely, the more acute the angle that the said faces of the bodies make with the trace, the more they decline, or are deflected, toward the quarter at which the front point of the body aims with respect to its course (as, in the preceding diagram, the comet's *u*). This would be easy to demonstrate still more clearly, if we wished to dwell somewhat longer on these matters. But since this matter is entirely settled in nature beyond all controversy, as there is no one who cannot very easily test it, both in water with the help of some plank and in the air from the crosswise motion of some disc, or disc-shaped body, I think there is no need to deduce it at greater length and more deeply.

[Margin: Quare curſum directum Cometæ citiſſimè deſerant ?] *Why do comets abandon a direct course very quickly?*

Therefore the comet turns its course aside and declines all the more, the nearer it approaches Q, namely the perpendicular falling from the Sun onto the trajectory, where in turn it directs its flat surface parallel to the run of its route. For the rest, as long as the comet keeps this direct position, it then indeed advances entirely straight; but it by no means keeps that position and course for long, because the angle of inclination varies very rapidly: indeed, at once, at the same moment at which the comet has passed the perpendicular so often mentioned. For we know for certain from geometry that more perpendicular lines than one cannot be drawn down from the same point, as Clavius also demonstrates from Proclus, Problem 10, Proposition 17, Book I of Euclid; likewise Corollary 2. Accordingly it is entirely necessary that the comet, at the same moment at which it quits the perpendicular, or leaves it behind, should turn itself round again for the same reasons stated before, and indeed by gradually presenting its body crosswise to the trajectory; but (mark this well) now downward, namely toward the Sun, just as at the beginning it had directed its body upward, away from the Sun.

[Margin: Quantò longiùs Cometa à perpendiculo proficiſcitur, tanto angulus inclinationis fit minor, motusq́; eò magis debilitatur.] *The farther a comet travels from the perpendicular, the smaller the angle of inclination becomes, and the more its motion is weakened.*

For the point *u* of the smaller and more acute side turns itself back again toward the tangent, namely toward the Sun, just as before it was receding from the tangent, or from the Sun; so much so that the exact contrary happens, and that at once, at the start, as soon as the comet has passed beyond the perpendicular, it, as far as possible, itself twists round, and deviates toward the run of the cometary disc, *u*: because the angle of inclination at the perpendicular is more acute. But the farther the comet advances, the nearer to a right angle the said angle becomes, while the deviation of declination, or of inclination, becomes smaller, and the motion is weakened and retarded more strongly, until (if the comet lasts that long) it in turn cuts the trajectory crosswise, or orthogonally, with both its spread faces; there the deviation then almost vanishes, and its motion becomes entirely straight, since there is no variation of the angle of deviation, as was shown above.

[Margin: Quemadmodum nulla ſectiò parabolæ in lineam omninò rectam tranſit, ſic etiam motus Cometarum nunquam penitùs fit rectus.] *Just as no section of a parabola passes into an entirely straight line, so too the motion of comets never becomes entirely straight.*

Although, if we take the matter strictly, it never really comes to the point where the comet sits on the trajectory with its disc so entirely exactly at a right angle, since the ray drawn out from the Sun to the comet never anywhere falls into one straight line with its orbit, unless the comet's track runs out straight to the centre of the Sun, or away from it; which, however, can happen very rarely (as you easily gather). Therefore the comet persists in continual deviation and deflection right up to its destruction, even though it is removed as far

as possible from the Sun, and it never passes across in a line straight in every respect (apart from that single case, about which [we shall speak] somewhat more fully shortly): just like the section of some parabola, which, though toward its extremities it may at last seem to imitate an almost straight line, nevertheless never passes into an absolutely straight line, as we know clearly from the nature of conic sections.

[Margin: Quando Cometæ à Sole, & rursùs ad Solem curſum inflectant.] *When comets bend their course away from the Sun, and again toward the Sun.*

For this reason, therefore, the comet (namely when with its course it describes a whole parabola, and the perpendicular from the Sun to the comet falls on the middle of its route) continually deviates upward, away from the Sun, from its beginning; but conversely, around its last appearance, downward toward the Sun: and indeed at the beginning more and more, the nearer the cometary body approaches the perpendicular, so that the greater curvature of the trajectory is always around the perpendicular.

[Margin: Major curvitas Trajectoriæ [[c/e]]irca perpendi[[c/e]]ulum eſt.] *The curvature of the trajectory is greater around [?] the perpendicular [?].*

Then again, the more it recedes from that perpendicular, the smaller the deviation becomes, and the curvature of the path of its route decreases.

[Margin: Motus Cometarum eſt parabolicus.] *The motion of comets is parabolic.*

Hence no line other than a parabolic one is traced by the course of the comet, because, as we have said, the greatest incurvation occurs around the middle of the track, but the least of all around the beginning and the end, as can be seen from the Figure set out above on p. 670.

[Margin: Quando vertex parabolæ ſupra lineam directionis incedat.] *When the vertex of the parabola proceeds above the line of direction.*

From this it is at the same time clearly evident that in those cases, when the comet marks out with its motion the whole section of a parabola, the vertex of that parabola never fails to stand above the tangent, or beyond the line of direction, with respect to the Sun: in a manner entirely contrary to that which balls shot from a cannon describe. For the vertex of the parabola described by the motion of the balls, in the horizontal direction, always falls below the line of direction, for entirely different reasons, already mentioned above.

[Margin: Quando cometæ ſemiparabolam tantùm deſcribant.] *When comets describe only a semiparabola.*

But if some comet were to burst forth from the atmosphere of the Sun, or from the vaporous orb of some other planet, where right from the beginning the straight line drawn out from the Sun onto the trajectory would be perpendicular, there, I say, matters stand quite otherwise. For in that place the comet would describe only a semiparabola, and would take its beginning from the point of the vertex; so that the section of the parabola would at that time proceed not above the line of the tangent, or of direction, but below it, just like balls shot from a cannon. Therefore the comets would then continually bend themselves

obliquely toward the Sun, and all the more, the farther they were removed from the Sun: as is abundantly clear from the diagram above.

Diagram. A full-page engraved plate with no text on the page, captioned *Fig. HH.* and signed by the author as engraver. A series of parallel horizontal rules runs across the upper part of the plate. Across them runs a chain of nine comets, each drawn as a narrow curved body with a hatched edge and joined to the next by a thin line: from the left the chain rises, runs nearly level through the middle, and descends to the right. Each comet is marked m at its left end and l at its right end; on the comets left of the middle the l stands at the raised upper tip, on those right of it the m stands at the raised upper end. Below the rules, solid and dotted lines run down from every comet and meet in a single point near the foot of the plate, marked K. The labels engraved on the plate:

- m, l (at the left and right ends of each of the nine comets).
- I, H, G, F, E, D, C, B, A (below the nine comets, from left to right, each beside the solid line running from its comet down to K).
- K. (below the point where all the lines meet).
- *Fig. HH.* (lower left): Figure HH.
- *Autor ſculpsit.* (lower right): Engraved by the author.

[Margin: Cometa, quando ex Atmoſphærâ ſuâ primùm exit,nunquam ferè à nobis deprehenditur.] *A comet, when it first leaves its atmosphere, is almost never detected by us.*

For the rest, since it hardly ever happens (as far at least as has been observed up to now) that we detect comets immediately, as soon as they leave the atmosphere, describing, that is, a whole section of a parabola. For most comets, as many as it has been granted us to notice up to now, have been seen only around the middle of the trajectory, either moving away from the perpendicular or proceeding toward it. And hence all of these have been seen to describe nothing but a semiparabola; and indeed below the line of direction when, as we have already touched on, they arose either from the atmosphere of the Sun or near the perpendicular, receding gradually more and more from the Sun; but above it when they were crossing toward the Sun: as will have to be confirmed by examples.

But first I consider it worth the effort to reveal and elucidate this parabolic motion, and the various inclinations of comets, somewhat more clearly still, through the motion of some vessel, boat or skiff, produced either by the wind or by the river.

[Margin: Motus Cometarum parabolicus ampliùs Schemate,atq́; curſu veli[[f/ſ]]ico dilucidatur.] *The parabolic motion of comets is elucidated more fully by a diagram, and by a sailing [?] course.*

And so that the matter can be set out the more accurately, let us add a diagram, by means of which it will be plain to everyone that vessels too, in water (like other things thrown in the air), never fail to describe, of nature's own accord, a motion most similar to the parabolic one, and that nature by no means shrinks from this motion.

[Margin: Navigia in flumine certâ lege commota, pariter curſum deſcribunt parabolicum, ut Cometæ in æthere.] *Vessels moved in a river by a fixed law likewise describe a parabolic course, as comets do in the aether.*

Let there be, in some river that flows with a straight and even current, a boat or some vessel without a rudder: for any oblong body, as has been said, has its own native tiller, or rudder. On the bank, then, let someone be present who holds that vessel back by two small ropes tied to the prow and the stern, that is, at m and l; to the end that the vessel, in that course, should always face the one holding it back, or the Director at K, with its oblong sides at a normal angle. But the Director must take care not to apply any force to the boat by accelerating or retarding it, or by some violent disturbance. Therefore, when the vessel thus begins to be moved from A along the run of the river, namely at a right angle with respect to the Director, it is then drawn away not only toward the course of the waters, B, but at the same time somewhat farther from the bank on which the Director stands, toward the opposite bank of the river: for the point of the vessel, m, or the prow, inclines that way. For nature of its own accord leans toward the side where the passage is easier and the resistance less. Accordingly the vessel too can swim across or pass through the river far more readily with its point m than with its longer side exposed to the current: as we have already shown above.

[Margin: Eadem eſt ratio navigiorum directionis & deviationis ac Cometarum.] *The principle of the direction and deviation of vessels and of comets is the same.*

For this reason the vessel bends a little and deviates from the earlier straight line of direction, and indeed toward B, that is, toward the side to which the prow m, namely the point, is carried nearer to the course of the river. And so, as it advances further, the point m, or the prow, must turn itself successively more directly toward the course of the river (since the Director, holding the vessel's ropes in his hand, steers it in such a way as to keep the length of the vessel constantly at an orthogonal angle), until it comes right to that part of the river opposite the Director K where the radius to the bank is perpendicular, namely E.

[Margin: Certo loco etiam navigia concitatiorem exercent motum.] *In a certain place vessels too exert a swifter motion.*

There the position of the little boat becomes parallel to the run of the river, and its progress is straighter, since prow and stern follow the course straight on and directly: hence in that part the motion of the vessel is at its fastest: namely, because there the trajection is easier and the water resists less; moreover, the force of the water running down strikes the stern at a right angle, where it is always strongest and exerts its power most of all. For straight rays are stronger than more oblique ones, according to that Mechanical and Optical Axiom already cited so often. Further, descending from here on to F, the vessel now again turns its point m, or prow, a little obliquely toward the nearer bank, that is, toward the Director K, and all the more, the farther it is driven onward

[in conſequentia] by the force of the water; because the Director, by means of the ropes, keeps the little boat in a perpendicular direction. From then on it is forced to bend away from that straight line of direction, described, as it were, under E, or from the natural run of the river (which that vessel could certainly have kept if it had remained in a parallel position, namely at E). And consequently it must be not only that the motion at that time becomes successively slower, since the length, or side, of the vessel is turned more and more toward the river and the path of its route, but also that it deviates and bends more and more (with respect, that is, to the line of direction), and so is moved forward on a curved, or rather parabolic, track.

The same principle holds also in comets.

[Margin: Motus Cometarum cum motu navium planè convenit.] *The motion of comets agrees entirely with the motion of ships.*

For since the bodies are disc-shaped (although on leaving the atmosphere they received a straight impulse at the beginning), and continually turn one or the other flattened face directly toward the Sun (in the manner of the solar spots), the comets too necessarily both begin and complete their trajections in the manner described. So the nearer some comet approaches the perpendicular drawn from the Sun onto the trajectory, that is, K E in the preceding diagram, the more it accelerates its course, or the more swiftly it crosses, and continually, little by little, turns its course obliquely: at the beginning, indeed, away from the line of direction, or from the Sun (namely when the comet describes a whole parabola with its motion), but at the last, once the perpendicular has been passed, always toward the line of direction, or toward the Sun.

[Margin: Sol idem præſtat in deviationeCometarū, quod Director ope funiculorum in directione velificationis.] *The Sun accomplishes in the deviation of comets the same thing that the Director accomplishes, by means of the ropes, in the direction of the sailing.*

For the very thing that the ropes, or rather the Director by means of them, accomplish in keeping the vessel's direction perpendicular, the Sun brings about in the motion of comets by its magnetic, or natural, force, so that the orthogonal line of the cometary body is constantly kept toward the centre of the world, namely the Sun. And it is the very same power that is customary in magnetic needles, by means of which they always set their length directly, at a right angle, toward the east and the west, and unceasingly direct their points to the north and the south.

In such a trajection, then, or sailing of a vessel, when, as we have said, the motion begins above the Director K (in the diagram above) with respect to the river, and ends again below him, a whole section of a parabola is described by that course, and its vertex is placed above the first line of direction.

[Margin: Navigia pariter nonnunquā integram, nonnunquam ſemiparabolam deſcribunt.] *Vessels likewise sometimes describe a whole [parabola], sometimes a semiparabola.*

But if the motion of that little boat were to take its first beginning near E, at a normal angle to the Director, then a semiparabola would be described below that line of direction, as everyone readily understands.

From this it is deduced clearly, again and again, that disc-shaped, or flat-shaped, bodies which are made successively more and more oblique by another motion, whether intrinsic or extrinsic, must for necessary reasons describe a course that is in some way curved, as much in water and air as in the aether.

[Margin: Corpora diſcea commota, atq́; ab alio motu impedita, omni loco curvum deſignant iter.] *Disc-shaped bodies, set in motion and impeded by another motion, mark out a curved path in every place.*

This course, however, is by no means circular; because from two inclined motions, from an entirely different impulse, arising at a different inclination, it is composed. Nor is it elliptical, since, if it were such, it would be more curved both at the beginning and at the end than in the middle, that is, along the length of the ellipse.

[Margin: Ex incurvatione Trajectoriæ cognoſcitur, an ſit trames Cometarum circularis, ellipticus,an verò parabolicus.] *From the curving of the trajectory it is recognized whether the track of comets is circular, elliptical, or indeed parabolic.*

But this has not been observed at all in comets, nor do the principles of this inclined trajection prove it; rather, the route of comets is more curved in the middle and straighter near the extremities, as has already been impressed so often. But if it could happen that a vessel crossed the water entirely transversely at a right angle, or a comet the aether in that manner, then certainly neither the ship nor the comet would deviate to the sides in the least, but would proceed continually and entirely straight on, as we showed above. We conclude, therefore, since a comet, like a vessel, at the beginning and at the end approaches more obliquely with respect to the trajectory, and nearer to a normal angle with the line of direction, that there its motion is also more direct than in the middle, around the perpendicular, where the inclination of the disc to the trajectory is straighter and the angle of the disc and the orbit is smaller; and consequently that the tracks of comets are entirely parabolic lines, which was to be demonstrated.

[Margin: An Trajectio Cometarum fia[[t/s]] juxta parabolæ, an verò hyperbolæ ſectionem.] *Whether the trajection of comets takes place [?] along the section of a parabola, or rather of a hyperbola.*

But, you will say, what if it were a hyperbolic line? This too is a definite section of the cone, drawn through the base, but parallel to no side; otherwise it shows a curvature, or hump, in the middle just as the parabolic section does, as the more learned are not unaware. I reply: it does not seem to us so very absurd that this motion can sometimes degenerate into a hyperbolic one as well; but I do not wish to argue so subtly about this matter at present, since it is not possible to discern it very accurately for lack of observations. Let it suffice that we have demonstrated, enough and more than enough, that the way of comets for the most part represents neither an entirely straight line, nor

a circular one, nor an elliptical one, but, besides these, some section of the cone, which is curved most of all in the middle and more and more straight toward each extremity; yet in such a way that it never ends in a straight line, even though it always comes nearer to one: as we have sufficiently seen from conic sections and their properties.

[Margin: Quare motus magis ad parabolam, quàm hyperbolam accedat.] *Why the motion comes closer to a parabola than to a hyperbola.*

Yet I am convinced that the track of comets comes closer to the parabolic section than to the hyperbolic. For the hyperbola is more humped around the vertex and more, as it were, peaked; again, on either side of the vertex the runs of its lines change more quickly and become straighter; whereas the parabola curves or swells gradually and slowly, and imitates a section of a circle more than the hyperbola just mentioned does. It therefore becomes very probable to us, since the cometary way by no means shows a pointed and prominent convexity, or vertex, of that kind, but rises slowly and gently into a hump around the middle, in proportion to the angle of inclination, that the tracks of comets represent the form of parabolic sections rather than of hyperbolic ones.

[Margin: Vtrùm omnes Cometæ ſimilem ſemper coni ſectionē curſu ſuo referant.] *Whether all comets always represent a similar section of the cone by their course.*

It is further asked whether the section of the motion of comets made through the base of the cone is entirely one and the same at every time and in all hairy stars; that is, whether it always represents a similar curving, flowing from an equal cone and described under the same angles. Certainly not: rather, the section of the cone already mentioned varies in many ways, and indeed differs one way and another in almost every comet. For just as there are cones of various kinds, namely right-angled, acute-angled and obtuse-angled; and moreover now larger, now smaller; so too there are infinitely many sections of them, parabolic as well as hyperbolic, now more pointed, now more obtuse around the vertex. Hence the runs of comets are likewise quite dissimilar and unequal to one another.

[Margin: Pleruńq; Trajectoriæ ſectionem obtuſi alicujus Coni deſcribunt.] *Trajectories for the most part describe the section of some obtuse cone.*

[Margin: In quantum Trajectoriæ incurventur.] *To what extent trajectories are curved.*

Nevertheless we shall not go astray in conjecture if we hold that the paths of comets are for the most part very obtuse sections, arising from obtuse cones. For the curvature at the vertex of the section, or of the trajectory, is rather slight, and the whole cometary way is for the most part curved only very little away from the straight track, or the straight line of direction; above all if the comet completes a short space along the length of its path and is of very brief appearance, when a deviation, or deflection, of scarcely a few minutes is detected; indeed, the greatest of all scarcely equals one or two degrees: as this very thing is proved more than enough from those eight comets adduced

above (and in Book I, Section X; likewise on page 563) and examined by due calculation, especially from the difference between their latitudes as observed and as deduced from the hypothesis, displayed for that purpose in the little table appended.

The Deviation of the Orbit of Some Comets [Deviatio Orbitæ nonnullorum Cometarum.]

	Year	Deviation
		Deg. Min.
Comet of the year	1531	0° 51′
	1532	0° 45′
	1577	0° 15′
	1585	0° 4′
	1590	0° 3′
	1607	0° 53′
	1618	2° 0′
	1652	1° 36′

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[Margin: Maxima deviatio Cometarum à lineâ directionis vix duos gradus adæquat.] *The greatest deviation of comets from the line of direction scarcely equals two degrees.*

From it we learn how far those comets deflected from the straight way of their path; and moreover that the sections of their tracks were very obtuse ones, belonging to certain very vast cones, since the greatest exorbitation of all scarcely grew to two degrees. But could any deviation at some time also grow stronger? This certainly cannot yet be determined, for lack of accurate observations; it will have to be put off until more precise findings on this matter are obtained [recte: obtineantur] by posterity.

[Margin: Verisimile videtur, dari in Cometis quibusdam deviationem aliquantò adhuc majorem.] *It seems probable that in some comets there is a deviation somewhat greater still.*

Meanwhile, however, it does not seem altogether absurd that other comets can sometimes deflect a little more widely from the straight track, especially those which, beyond the rest, traverse a great space of the heavens and are of very long duration.

From what has been adduced, then, one may judge more than fully that, since not each and every comet displays one and the same deviation, that conic section too is certainly not of one kind, nor arising from an entirely similar

[614] On the page the table stands in a ruled frame at the right of the text, beside the ten short lines that follow it here, with its caption inside the frame. The first column has no head; its label, Cometa anni (comet of the year), stands in two lines level with the 1531 and 1532 rows, and the column is otherwise blank. The heading Deviatio stands over two columns headed Gr. (degrees) and Min. (minutes), given here as one column. Rules divide the rows into three groups: 1531–1577, 1585–1607 and 1618–1652.

cone; but, just as cones have their own and diverse heights, so too their bases possess circles of the most diverse size.

[Margin: Pro Cometæ à Sole intervallo & perpendiculo, ſectio parabolæ, ſeu incurvatio Trajectoriæ nunc acuminatior, nunc obtuſior eſt.] *According to the comet's distance from the Sun and the perpendicular, the section of the parabola, or the curving of the trajectory, is now more pointed, now more obtuse.*

Accordingly, by reason of the different distance of the comet from the Sun — that is, the nearer the comet's trajectory approaches the Sun, or the farther it is removed from it, and the more widely that trajectory extends on either side, as it were, of the Sun, or of the point of the perpendicular drawn from the Sun to the route, or the longer it is as a whole — the more pointed or the blunter the vertex of the parabola and of the hyperbola turns out, and the less or the more it swells. The vertex is indeed less peaked when the comet passes the Sun close at hand than when it crosses at a distance.

[Margin: In quibus Cometis Trajectoria hyperbolā, & in quibus parabolam referat.] *In which comets the trajectory represents a hyperbola, and in which a parabola.*

Conversely, at a nearer distance from the Sun the sides of the sections are straighter than at a more remote one; so that I might rightly say that at those nearer removes there are hyperbolic sections, but at the farther ones parabolic sections: as these things can be demonstrated to the eye without difficulty from the two diagrams placed alongside.

From the first figure, in which S is the Sun and i h n the way of the comet, it is clear that at the rising and the exit, that is, at i h g e and at f l m n, the angle of inclination of the disc and the orbit varies gradually and slowly, but at the vertex, namely at b a and c, very rapidly. For this reason, in that place too the run of the comet at its first rising and at its last extremity changes slowly and at a scarcely perceptible rate; by contrast, in the middle, at b, namely a and c, very swiftly and with evident curving, since the Sun is very near the trajectory.

Diagram. The first of the two diagrams set below the opening lines of the page. A straight base line runs across the figure; above it a curved line, highest in the middle, carries short cross-strokes; straight lines run from points on the curve and on the base to a single point S below the middle of the curve. Labels as engraved, from left to right along the curve:

- i (leftmost raised point of the curve)
- h
- g
- e
- b
- a (at the top of the curve, above a short flat bar, from which a vertical line drops to S)
- c
- d
- f
- l

- m
- n (rightmost raised point)
- S (the point below the curve where the lines meet; the Sun, per the text)

Diagram. The second diagram, set below the first. A long arc, highest in the middle, carries short cross-strokes; straight lines run from its points down to a single point S near the foot of the figure; a little above S a short arc crosses the same lines from O through P to Q. Labels as engraved:

- A (at the top of the long arc, on the vertical line)
- I (at the left end of the long arc)
- P (above the middle of the short arc)
- O (left end of the short arc)
- Q (right end of the short arc)
- S (the point where the lines meet)
- Autor ſculpsit. (to the right of the figure: Engraved by the author.)

[Margin: Quando via Cometæ Soli propior, Trajectoria in medio curvior eſt.] *When the way of the comet is nearer to the Sun, the trajectory is more curved in the middle.*

For the nearer the Sun stands to the cometary way, the straighter the course is at the beginning and the end; on the contrary, in the middle, around the vertex of the section, it is so much the more curved. In the other diagram, however, in which the Sun is as far as possible from the trajectory, the angle of the disc and the orbit varies there little by little and gently. Consequently that line is curved more quickly from its beginning and at its end, like a parabolic section.

[Margin: Rursùs verò, quando longiùs à Sole diſtat, via itineris in medio obtuſior eſt.] *But again, when it is farther from the Sun, the way of the path is more obtuse in the middle.*

For at these farther removes of the trajectory from the Sun, the angle of inclination, over a greater space of the path, has no need to vary any more than it does at the nearer distance over a much smaller interval of the track: as may likewise be gathered, more than amply, from the section O P Q. There, I say, the variation of the angle of inclination from O to P is the same as is found in that larger upper section from I to A, although in this smaller section, from O to P, the comet has scarcely a fifth part of the aether to traverse, in relation to I A.

[Margin: OmnesCometæ, qui Solem prætervehuntur, curſum denotant conicum.] *All comets that are carried past the Sun mark out a conic course.*

Hence it is abundantly shown that the curvatures of trajectories arise from the position of the trajectory relative to the Sun; in such a way that all the courses of hairy stars which pass the Sun are always curved, like conic sections, either parabolic or hyperbolic.

But, I say, so that you may understand the matter rightly: it is so with comets to the extent that they are carried past the Sun, or where the trajectory is continued beyond the Sun; whereas, when a comet its motion straight toward

the centre of the bo- dy of the Sun were to direct, as if it had to be dashed against it — although such a case can hardly come about easily, since no example of it is given — nevertheless it can sometimes happen that a comet crosses in the manner described toward the Sun or away from the Sun, and does not strike the Sun with its body at all, because it can be dissipated on the way before it reaches the Sun in its course.

[Margin: Si Cometa rectà ad Solem, vel à Sole trajiceret, nulla daretur variatio inclinationis diſci, & per conſequens ibidem omninò in directum, motu quidem æquabili progrederetur.] *If a comet crossed straight toward the Sun, or away from the Sun, there would be no variation of the inclination of the disc, and consequently it would there proceed entirely straight on, and indeed with uniform motion.*

In such a case, I say, and indeed in this one alone, the trajectory advances entirely straight into the part of the aether opposite from the Sun, so that the comet does not deviate even in the least, this way or that, along its whole path, nor trace any conic section. The reason depends on this, as we touched on a little earlier: if a newly formed cometary body were ejected from its atmosphere in such a way that it at once turned its disc straight toward the Sun at a normal angle, the angle of inclination of the disc and the orbit would then keep 90° with the utmost constancy. Therefore, since there is no variation whatever of the inclination of the disc there, the comet accordingly does not deflect in any way from that straight track it has taken up, but is compelled, as if by force, to proceed entirely and continually straight on; and moreover (which is especially to be noted) to move with a perpetually uniform and equally swift course from the beginning all the way to the end, because of the constant angle of inclination of the disc; and indeed, understand, for as long as the cometary body remains equally fit for motion.

[Margin: Eadem eſt ratio velifici curſus.] *The same holds for a sailing course.*

For I here entirely exclude the difference of motion that arises from the rarity and density of the matter, supposing a mature and constant body: just as with a vessel driven entirely crosswise in a river, presenting, that is, one or the other of its sides forward, and kept constantly by some force in that position, namely at a right angle to the current of the water. Then, I say, if the impulse were uniform and of one kind, the vessel would not stray in any way from the straight route (unless some obstacle intervened, which, however, I set entirely aside on this occasion), but would proceed perpetually on an entirely straight way. But if the trajectory passed the Sun even at only the smallest distance, then indeed there would be no straight motion at all; rather, it would of necessity describe a conic section, as has already been shown at length above.

Moreover, it will not be out of place, I think — and it will also supply the occasion and the material for weighing and searching out the secrets of comets the more fully — to set here before the eyes of each reader a genuine and accurate delineation of all the preceding comets: namely, by what way the trajectory, or rather the trace (since the trajectory cannot be described on a plane so very exquisitely and distinctly), proceeded with respect to the Sun;

how the rays drawn from the Sun fell on each comet; and this in due proportion and at the true distance.

[Margin: Ex genuinâ deſcriptione radiorum Solarium ex Sole ad veſtigium eductorum innoteſcunt inclinationes Cometarum.] *From a genuine drawing of the solar rays drawn from the Sun to the trace, the inclinations of comets become known.*

In this way not only will the inclinations of all the comets above become clearly evident, in what manner they were successively changed, but the true motion in the trajectory will also be revealed: why in this comet it turned out swifter, in that one, again, slower, and varied itself wonderfully. Then we have assigned to each comet the genuine run of its path, so that it may be clear of what kind its conic section was. From these, moreover, many things will flow, as pleasant as they are very well worth knowing, which will without any doubt furnish the occasion for ranging further into this field of most delightful questions.

Diagram. The left part of a folding engraved plate with no text on the page, captioned *Fig. II.* The plate runs on beyond a fold near the right edge of the page, where only a narrow strip of its further part is visible. It shows five comet traces. Each is a straight horizontal line crossed by short oblique ticks, one for each dated position; from every tick a straight line runs down to a single point, marked S, and a dotted perpendicular is dropped beside each fan of lines. The dates are written along the lines; on the middle trace and the lower right trace they are engraved upside down. The labels engraved on this part of the plate:

Upper left, the comet of 1472:

- *Cometæ 1472* (above the trace): Comet of 1472.
- *O* (left end of the trace); *H* (right end).
- *Perpendic.* (along the dotted line at the left): Perpendicular.
- Along the lines, from left to right: 27, with *Febr* (February); 20; 13; 6, with *Februar.* (February); 30; 23; 20; 13, with *Januarii* (January).
- *Vestigium* (right of H, below the trace): Trace.
- *S* (far below at the left, where the lines meet).

Upper middle, the comet of 1531:

- *Cometæ 1531* (above the trace): Comet of 1531.
- *H* (left end); *O* (right end).
- Along the lines, from left to right: 13, with *Augusti.* (August); 15; 17; 19; 21; 23.
- *Perpend.* (along the dotted line at the right): Perpendicular.
- *S* (where the lines meet).

Upper right, the comet of 1532:

- *Cometæ 1532* (above the trace): Comet of 1532.
- *O* (left end).
- *Novemb. 8* (along the line at O): November 8. *Octobr. 31* (along the next line): October 31.
- *Perpend.* (along the dotted line beside them): Perpendicular.

- 19 and 14 (at the next two ticks).
- Along a line running into the fold: Octobri- [?], its end lost in the fold. Along a dotted line running into the fold: Perpend- [?], its end lost in the fold.
- *S* (where the lines meet).

Middle, the comet of 1607:

- *Vestigium* (left of the trace): Trace.
- *H* (left end); *O* (right end).
- *Cometæ 1607* (above the trace): Comet of 1607.
- Upside down along the lines, from left to right: 26, with *Septembris* (September); 2 and a second figure, 0 or 8 [?]; 1, with *Octob.* (October); 4; 7; 10; 13; 16; 19; 22; 25, with *Octobris.* (October).
- *Trajectoriæ.* (right of the trace, beyond the point where the fan of the comet of 1532 meets): Of the trajectory.
- *Perpendic.* and *Perpendic.* (along two dotted lines): Perpendicular.
- *S* (where the lines meet, low on the right).
- Right of the trace, above it: *Cometæ* (Comet of) with a 1, the rest of the year lost in the fold [?]; below it, along a line running into the fold: Febru- [?], its end lost in the fold.

Lower left, the comet of 1652:

- *Cometæ 1652.* (above the trace): Comet of 1652.
- *O* (left end); *H* (right end).
- Along the lines, from left to right: 8; 5; 2, with *Januarii* (January); 30; 26; 23; 20; 17; 14, with *Decembris* (December).
- *Vestigium Trajector.* (right of H): Trace of the trajectory.
- *Perpendic.* (along the dotted line dropped from the trace): Perpendicular.
- *S* (near the foot of the plate, where the lines meet).

Lower right, a trace without a legible caption on this part of the plate:

- At its left end a small oval, either the figure 0 or the letter O [?].
- Upside down along the lines, from left to right: 17; 12; 7; 2; *Januarii* (January); 28; 24; and at the fold a 0 whose preceding figure is covered by the fold [?].
- *S* (where the lines meet).

Caption:

- *Fig. II.* (lower left): Figure II.

On the strip beyond the fold:

- A label of two or three small letters ending in a, cut by the fold [?].
- *Perpendic.* (along a dotted line): Perpendicular.
- *H* (standing in the fold, at the left end of a trace); *S* (where a fan of lines meets); 26 (at the first tick of that trace).
- A label beginning with a capital M and an a, the rest beyond the edge of the image [?].
- A label ending in -metæ, its opening in the fold [?]; 16 (at the first tick beyond the fold, on the lower right trace).

The right part of the folding plate *Fig. II.*, whose left part and caption stand on the previous page. At the left edge the plate runs into the fold, and a narrow strip of its left part is visible beyond it. The right part shows three more comet traces drawn in the same way: a straight horizontal line crossed by short oblique ticks, a straight line running from each tick to a point marked S, and a dotted perpendicular beside that point. Dates are written along the lines; on the lowest trace they are engraved upside down. The labels engraved on this part of the plate:

In the strip left of the fold:

- An angled label beginning *Traje-*, its end lost in the fold [?].
- Fragments of two labels at the very edge of the image [?].
- 3 (beside a line); a label beginning *Janu-*, along a dotted line, its end lost in the fold [?].
- A year beginning 159, its last figure cut by the fold [?]; below the trace, 23 and a figure cut by the fold [?]; along a line below, *Februarii* (February).
- Below the lowest trace, upside down: 20, and a figure cut by the fold [?].

Upper trace, the comet of 1577:

- *Cometæ 1577* (above the trace): Comet of 1577.
- *Trajectoriæ.* (below the left part of the trace): Of the trajectory. 2 (further left, beside the fold).
- *H* (at a tick near the left of the trace); *O* (right end).
- Along the lines, from left to right: *Novembris. 13* (November 13); 19; 25; *Decembr. 1* (December 1); 7; 13; 19; 25; 31; 6, with *Januarii* (January).
- *Perpendic.* (along the dotted line): Perpendicular.
- *S* (far below at the left, where the lines meet).

Middle level, a short trace running from the fold:

- Along its lines, from left to right: 26; 1, with *Martii* (March); 4; 6.
- *O* (its right end).

Middle level, the comet of 1585:

- *Cometæ 1585* (above the trace): Comet of 1585.
- *O* (left end); *H* (right end).
- Along the lines, from left to right: 11; 7; 3, with *Novembr.* (November); 30; 26; 22; 18; 14; *Octobris 10* (October 10).
- *Perpendic.* (along the dotted line at the right): Perpendicular.
- *S* (near the foot of the plate, where the lines meet).

Lower trace, the comet of 1618:

- Caption above the trace, *Cometæ anno 1618*: Comet of the year 1618 (the middle letters of the first word are covered by the fold [?]).
- Upside down along the lines, from left to right: 16; 13; 10; 7; 4; *Decembris 1* (December 1).
- *H* (right end).
- *Vestigium Trajectoriæ* (right of H): Trace of the trajectory.
- *Perpendic.* (along the dotted line): Perpendicular.
- *S* (where the lines meet).

At the foot of the plate:

• *Autor ſculpsit.*: Engraved by the author.

[Margin: Quâ ratione præcedentia Schemata Cometarum fuerint delineata.] *How the preceding diagrams of the comets were drawn.*

And so in the accompanying figure we have drawn all those comets that have been brought onto the stage: namely, in what way the disc in each one was inclined to the trace over the whole time of its duration, where at the same time we took true account of the distance between the Sun and the comet, and also of the angle of the trajectory and of the lines of sight drawn from the Sun. In all the drawings H is the position of the comet at the beginning, O at the end of the apparition. S represents the Sun; the line H O the trace of the comet; the lines marked with dots, the perpendicular falling from the Sun onto the trace; the shorter little lines, which cross the solar rays at a right angle and form a definite angle of inclination with the trajectory, the cometary disc; while the intervals enclosed by the solar lines of sight represent the true motion in the trace or trajectory.

[Margin: Quò magis Cometa ad perpendiculum accedit vel recedit, eo magis motus ejus intenditur vel remittitur.] *The more a comet approaches or recedes from the perpendicular, the more its motion is intensified or slackened.*

It is therefore abundantly clear (this is what was asserted in that Theorem XVI, on the motion and trajection of comets, on p. 640, and was also demonstrated at length in its place by physical reasons) that, namely, the true motion and trajection of comets is swiftest when the straight line drawn from the Sun to the comet is perpendicular; and that the further the comet recedes from this perpendicular, the more it slackens its motion, while it intensifies it the nearer it approaches that perpendicular. For it is evidently plain from all the diagrams of the comets that the space between two rays drawn from the Sun S to the trace is wider the nearer it is to the perpendicular; and, conversely, the further it stands from it, the more compressed it is: in an equal space of time, that is.

1. In the comet of the year 1472 the true motion in its trajectory is found to be much smaller around the beginning, H, namely on 13 January, than at the end, around O, namely on 27 February.

[Margin: Schemate demonſtratur, cur motus proprius verus in Cometâ 1472 initiò multò tardior fuerit, quàm deinceps.] *It is shown by a diagram why the true proper motion in the comet of 1472 was much slower at the beginning than afterwards.*

For, as is clear from the following Table (in [?] which the true motion in the trajectory has been computed for any days whatever), that daily trajectory motion of the comet [?] of the year 1472 amounted at the start, namely on 14 and 15 January, to only 33 semidiameters of the Earth; but at the bottom of its course, where it was approaching the perpendicular, it became much swifter, so that in one day, around 26 and 27 February, it covered almost 100 semidiameters of the Earth. The cause is this, as has been demonstrated at length in what precedes: that the disc of the comet was more oblique to the trajectory from its rising than at the last, namely around 20 and 27 February,

when the disc was advancing almost parallel to the trajectory O H. And so this true motion in this comet grew from day to day, because the motion was tending toward the perpendicular. But I would have you take careful note here, and distinguish between the true and the apparent motion; for at present the discussion is about nothing other than the true proper motion in the trajectory. But if the apparent motion were to be dealt with, it would have been most rapid around 22 January. For at that time the apparent motion came to almost 40°, both from observation and from calculation; but around its extinction, to only two or three degrees. For what causes that happened has already been fully shown earlier. But with this motion, I say, we have nothing to do on this occasion; only with the true motion in the trajectory.

The Daily True Motion of the Comets in the Trajectory [Motus diurnus Cometarum verus in Trajectoriâ.]

1472		1531		1532		1577		1585		1590		1607		1618		1652	
Jan.	S.Ter	Aug.	S.T.	Oct.	S.T.	Nov.	S.T.	Oc-tob.	S.T.	Febr.	S.T.	Sept.	S.T.	Dec.	S.T.	Dec.	S.T.
14	33	14	84	4	71	14	118	10	161	24	176	27	52	2	198	15	110
15	33	15	86	5	70	15	118	11	161	25	175	28	54	3	197	16	103
16	34	16	90	6	70	16	117	12	160	26	173	29	56	4	195	17	98
17	35	17	95	7	69	17	116	13	160	27	172	30	57	5	194	18	94
18	36	18	101	8	68	18	116	14	159	28	171	Oc-tob.	59	6	191	19	91
19	37	19	109	9	68	19	115	15	159	Mar.	170	2	62	7	189	20	88
20	38	20	118	10	67	20	115	16	159	2	168	3	65	8	187	21	86
21	39	21	127	11	67	21	114	17	158	3	165	4	69	9	185	22	83
22	40	22	137	12	66	22	113	18	158	4	161	5	72	10	184	23	81
23	41	23	150	13	66	23	113	19	158	5	158	6	76	11	181	24	80
24	43			14	65	24	112	20	157	6	154	7	79	12	178	25	79
25	45			15	65	25	112	21	157			8	83	13	175	26	78
26	47			16	64	26	111	22	157			9	87	14	173	27	77
27	49			17	64	27	111	23	157			10	91	15	170	28	77
28	51			18	63	28	110	24	157			11	95	16	167	29	76
29	52			19	62	29	110	25	157			12	100	17	164	30	75
30	54			20	62	30	110	26	157			13	105	18	162	31	74
31	56			21	61	Dec.	109	27	157			14	109	19	161	Jan.	74
Feb.	58			22	61	2	109	28	157			15	114	20	159	2	73
2	60			23	60	3	109	29	157			16	120	21	158	3	73
3	62			24	60	4	108	30	157			17	127	22	157	4	73
4	64			25	59	5	108	31	157			18	134	23	157	5	72
5	66			26	59	6	108	Nov.	157			19	142	24	156	6	72
6	68			27	58	7	107	2	156			20	152	25	155	7	72
7	70			28	57	8	107	3	157			21	164	26	153	8	72
8	72			29	57	9	107	4	157			22	178	27	152		
9	74			30	56	10	107	5	156			23	193	28	150		
10	75			31	55	11	107	6	157			24	210	29	146		
11	77			Nov.	54	12	107	7	157			25	220	30	142		
12	79			2	53	13	106	8	157					31	138		

1472	1531		1532		1577		1585	1590	1607		1618	1652	
Jan.	S.TerAug.	S.T.	Oct.	S.T.	Nov.	S.T.	Oc-tob.	S.T.	Febr.	S.T.	Sept.	S.T.	Dec.	S.T.	Dec.	S.T.
13	81		3	52	14	106	9	156					Jan.	135		
14	82		4	51	15	106	10	157					2	133		
15	83		5	50	16	106	11	156					3	131		
16	85		6	49	17	105							4	130		
17	86		7	48	18	105							5	129		
18	88		8	47	19	105							6	128		
19	90				20	105							7	127		
20	91				21	105							8	126		
21	92				22	105							9	125		
22	94				23	104							10	124		
23	96				24	104							11	122		
24	97				25	104							12	121		
25	98				26	104							13	121		
26	99				27	104							14	121		
27	100				28	104							15	120		
					29	104							16	120		
					30	103							17	120		
					31	103										
					Jan.	103										
					2	103										
					3	103										
					4	103										
					5	103										
					6	103										

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[Margin: Cometa ad perpendiculū perrexit, & idcircò motus quoq́; invaluit.] *The comet proceeded toward the perpendicular, and for that reason the motion also grew stronger.*

2. The comet in the year 1531 likewise set its course toward the perpendicular, but with this difference: this one passed across against the order of the

[615] Arrangement of the page. The table fills the page under its caption, with no other text. Each comet has a pair of columns under its year: the days of the month on the left, with the month of the first entry at the head and each new month named in place of its first day; on the right the daily true motion in the trajectory, headed S.Ter. for 1472 and S.T. for the others, abbreviations left as printed (the text of the preceding page gives the same quantity in Semid. T., semidiameters of the Earth). On the page each year stands centred over its pair and the month and unit stand in a second heading row; here they are joined in one heading row. The rows are grouped in threes by printed rules, level across the whole table, so the entries of different comets stand side by side by row only; the rules are not reproduced. Each column ends at its last printed entry, and the blank cells below are blank on the page. All figures, days, months, years and units on this page were read at zoom 3 or more, and the page number 688 likewise; the running-head words were read at zoom 1. The 1585 column does not run one way: in its last eleven rows the value moves between 157 and 156 (156 against the second, fifth, ninth and eleventh of November), as printed.

signs, that one in the order of the signs. Here it must be noted once more that in all the diagrams the comets passing from H toward O follow, leftward, the motion of the planets and the circumgyration of the solar body, while those [going] rightward strive in the contrary direction. Therefore, because this comet also made toward the perpendicular, the motion in the trajectory likewise grew stronger, and at the end it became much more rapid than at the beginning.

[Margin: Ratione initii & finis, motus hujus Cometæ ferè duplo velocior factus eſt.] *Comparing beginning and end, the motion of this comet became almost twice as swift.*

For around 14 and 15 August it amounted to only 80°, more or less; but on the 23rd of the same month it increased to almost 150 semidiameters of the Earth. Indeed, had it appeared for longer, it would have shown itself much swifter still, since at that time it was still far from the perpendicular, so that it would scarcely have reached it within the course of 4 or 5 days.

[Margin: Quare Cometa 1532 Theoremati & Schemati quaſi adverſari videatur.] *Why the comet of 1532 seems, as it were, to oppose the theorem and the diagram.*

3. At first sight, indeed, the comet of the year 1532 seems as if it were plainly opposed to our theorem (namely, that comets nearer the perpendicular are swifter) and to the things we have brought forward, since the perpendicular of this comet appears to fall on the trace nearer O, at 31 October. But I would have you know that if the trajectory is set up at its proper elevation above the trace, the perpendicular in fact falls not near O but at H, and indeed to its right, as we wished to indicate, after a fashion, by dots. Therefore the comet is carried not toward the perpendicular, as anyone would conjecture from the diagram at first glance, but away from the perpendicular; and for that reason the motion also decreases gradually from day to day, according to our Theorem XVI, as the Table shows.

[Margin: Motus Cometarum ad perpendiculum ſemper creſcit, à perpendiculo verò proveniens decreſcit; atq; ita ſub perpendiculo eſt concitatisſimus.] *The motion of comets toward the perpendicular always grows, while proceeding from the perpendicular it decreases; and so under the perpendicular it is most rapid.*

All the remaining comets, whether they were direct in longitude or retrograde, likewise prove this clearly: that the motion tending toward the perpendicular always increased, as happened in the years 1472, 1531 and 1607, while that proceeding from the perpendicular decreased, as occurred in the years 1577, 1585, 1590, 1618 and 1652, as is plain to anyone from the diagrams and the preceding Table. We have therefore demonstrated more than fully, both by most illustrious examples and by evident physical reasons, that the motion of comets is swiftest around the perpendicular, or the straight line drawn from the Sun to the trajectory; and that comets approaching that perpendicular continually intensify their true motion in the trajectory, while those departing from it slacken their motion.

[Margin: An Cometæ pari velocitate quà motum verum ferantur; nec non proportio celeritatis in omnib9 ſit ſemper eadem?] *Whether comets are carried with equal speed as regards their true motion; and also [whether] the proportion of speed is always the same in all of them.*

All these things having thus been investigated and demonstrated, we now take up in order the question that we touched on at p. 677 of this Book IX: namely, whether all comets are carried with equal speed in their trajectory as regards their true proper motion? Then, whether they perpetually observe a definite proportion of speed, from some natural power? The first question can readily be resolved; and by experience itself and by sure observations of the preceding comets, above all by the table above (in which their true motion in the orbit has been computed for each single day), it can be shown to the eye quite abundantly that the course of any comet whatever varies, both as to its beginning [and] middle and as to its end. For the comet in the year 1472 covered scarcely 33 semidiameters of the Earth in one day; the comet in the year 1531 travelled through 84 semidiameters of the Earth; the comet of 1532, 47 semidiameters of the Earth;

the comet of 1577, 103 semidiameters of the Earth; the comet of 1585, 156 semidiameters of the Earth; the comet of 1590, 154 semidiameters of the Earth; the comet of 1607, 52 semidiameters of the Earth; the comet of 1618, 198 semidiameters of the Earth; and the comet of 1652, 72 semidiameters of the Earth, namely where they were slowest. Conversely, the small table attached here shows with what speed they passed across where they were found to be most rapid.

[Margin: Diverſitas motus proprii no nullorum C nmetarū in omâ eorum ſumocitate. ve-] *The diversity of the proper motion of some comets at their greatest speed.* [?]

Comet, year [Cometa Anno]	Proper motion in the trajectory [Motus proprius in Trajectoriâ]
1472	100 Sem. T.
1531	150
1532	71
1577	118
1585	161
1590	176
1607	220
1618	120
1652	110

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It is therefore most certain that no comet is, or ever was, entirely equal to any other as regards its proper motion in its orbit.

[Margin: An ſtatis temporibus æquales gradus velocitatis Cometæ exerceant, nondum hactenus detectum eſt.] *Whether comets keep up equal degrees of speed at fixed times has not been discovered so far.*

But if you now ask what the physical cause of this is, and whether comets observe definite degrees of speed at fixed times? This is certainly a matter calling for a loftier endeavour, since no one at all, neither among the ancients nor among the moderns, has so much as touched this question with the tips of his lips, still less left us any sufficiently reliable observation by which it could be rightly and duly demonstrated — if you except what we can derive from some eight or nine comets; and even among those comets are found the first three, namely those of Regiomontanus and Apian, which were observed only with a cruder skill [rudiori … Minervâ]. However that may be, I nevertheless trust, God willing, that I shall bring forward reasons that are not only in the best agreement with our hypothesis and with Nature herself, but that will also, without doubt, not so very much displease, if not all philosophers, at least most of them (if you except the Aristotelians and those who are wholly opposed to our theory).

[Margin: Diverſæ rationes concurrunt, ob quas motus adeò datur in Cometis diverſus.] *Diverse reasons combine, on account of which the motion in comets is found to be so diverse.*

To begin with, therefore, I lay down that this motion, as regards speed and slowness, turns out now one way and now another, not by chance but for definite causes; these causes, however, are diverse, as will shortly be explained more fully. This diversity of motion could indeed be attributed in part to the inclination and variation of the cometary disc, as we have discussed at greater length in various places; on account of this the motion is now intensified and now slackened, according to the more oblique or more upright position of the cometary disc in the trajectory.

[Margin: Cur inclinatio diſci non unica cauſa ſit variationis velocitatis.] *Why the inclination of the disc is not the only cause of the variation in speed.*

But this is by no means the genuine cause that accelerates or retards the motion along its path. For in comets in which the inclination of the disc was

[616] Arrangement of the page. The small table stands within the text block, to the right of the shortened lines 6–14, after the sentence that announces it; it is given here after that sentence. On the page the heading of each column is set in two lines (Cometa over Anno; Motus proprius over in Trajectoriâ); they are joined here. The unit Sem. T. (semidiameters of the Earth) is printed only against the first value, and is not repeated here. The rows are grouped in threes by printed rules, which are not reproduced. All years, values and heading words of the table were read at zoom 3 or more. The value 120 for 1618 is the smallest of the 1618 column in the table of daily motion (p. 806), not its largest (198), while the text above gives 198 for 1618 among the slowest; both are kept as printed.

one and the same, one and the same speed or slowness would also be found; but we experience entirely the contrary.

[Margin: Etiamſi angulus inclinationis in Cometis propemodùm ſit æqualis,motus tamen abundè variatur.] *Even if the angle of inclination in comets is nearly equal, the motion nevertheless varies widely.*

For, as can be seen from any observations of comets whatever: even if you attend to those days on which the angle of the Sun's ray with the trajectory of two comets was nearly equal — that is, where the angle of inclination of the disc, which the comet's disc forms with the trajectory, is the same — there, I say, the motion of these comets is so far from being of one kind that it rather differs from one comet to the other as widely as possible, as plainly appears from the small table set below. There you will find that although in eight comets the angle of the Sun's ray with the trajectory was of almost the same size, 60°, more or less, yet the motion of those comets was very diverse and unequal: in some it was found to be only 70 semidiameters of the Earth, in others again up to 100, 150, indeed 200 semidiameters of the Earth.

Comet	Month and day	Angle of the Sun's ray and the trajectory	Motion in the trajectory
1472	Febr. 6	62° 50′	68 Sem. T.
1531	Auguſt. 19	62° 22′	109
1532	Octob. 4	60° 57′	71
1577	Novemb. 13	57° 4′	118
1585	Octob. 20	61° 16′	157
1590	Febr. 23	60° 0′	176
1607	Octob. 23	62° 0′ nearly	193
1653	Januar. 5	62° 34′	72

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Moreover, even if you suppose all these comets to be at an equal inclination, whether greater or smaller, they nevertheless refuse equal degrees of speed or slowness of motion. From this it can be gathered, and not obscurely, that still other reasons lie hidden beneath, on account of which this diversity is brought about. Meanwhile, however, I willingly grant that the inclination of the disc, or the angle of the Sun's ray with the trajectory, is not the least cause on account of which the motion is in fact accelerated and retarded, as has both been proved by what precedes and will be demonstrated still more clearly by what follows.

[617] Arrangement of the page. This small table stands at the top left of the page with the first nine lines of text set short beside it; it has no caption. Its heads are set over two or three lines on the page (Cometa; Quo menſe & die; Angulus radii ☉ & Trajectoriæ, with Gr. and Min. under it; Motus in Trajectoriâ); they are given here in English. The angle is printed as two figures, degrees and minutes, under Gr. and Min.; the months are kept as printed. The unit Sem. T. (semidiameters of the Earth) is printed only against the first value of the last column. The word rendered nearly is ferè, printed after the 0 in the 1607 row. The rows are grouped by printed rules, which are not reproduced. All cells and heads were read at zoom 3. The year in the last row is printed 1653, where the table of daily motion (p. 806) heads the same comet 1652.

[Margin: Vnius quidem Cometæ variatio motus in ſuâ Trajectoriâ ex inclinationis variatione maximâ ex parte dependet; minimè v[[c/e]]rò ſi diverſi Cometæ inter ſe invicem comparantur.] *The variation of motion of a single comet in its own trajectory indeed depends for the most part on the variation of the inclination; but by no means if different comets are compared with one another.*

Indeed, if you attend to the motion of one comet by itself alone, setting the others aside, this inclination is the principal reason for the intensification and slackening of the motion. For it is clearly evident that, according as the variation of the inclination, or the angle of the Sun's ray with the trajectory, is greater or smaller in the comet, and as the distance of the comet from the Sun then varies now more and now less, namely over the whole apparition, the motion also follows nearly the same proportion. But so that all this may be demonstrated and grasped the more clearly, we have computed for certain days both the motion of the comet from the Sun and the angle of the Sun's ray with the trajectory, as well as the distance of the comet from the Sun, and have set them down in a table.[618]

Date	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
Januar.	In the year	1472	
13	5360	52° 15′	
			1° 50′
20	5200	54° 5′	
			1° 10′
23	5080	55° 0′	
			3° 20′
30	4950	58° 20′	
			4° 30′
Feb. 6	4740	62° 50′	
			6° 0′
13	4540	68° 50′	
			7° 30′

[618] Arrangement of the table that follows. On the page it is one ruled table in two halves standing side by side under one head; the left half is given first, then the right. Each half has a column of dates (the month printed where a year begins and where the month changes), the distance of the comet from the Sun in semidiameters of the Earth (the unit row prints Sem. with the Earth sign), the angle of the Sun's ray with the trajectory in degrees and minutes (Gr. Mi.), and the motion of the comet from the Sun in degrees and minutes (Gr. M.; the left half heads this column with the Sun's sign, the right half with the word Sole). Each year opens with a line carrying the month, ANNO and the year. The figures of the motion column are printed between the lines of the dates, each between the two dates whose interval it follows, and stand here on rows of their own; the last motion figure of 1531 (left half) and the last two of 1585 (right half) are printed level with the lines of the dates 23, 7 and 11, and stand on those rows. The right half ends three lines short of the left, with blank ruled space below it. All figures were read at zoom 3.

Date	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
20	4350	76° 20′	
			9° 0′
27	4251	85° 24′	
Aug.	In the year	1531	
13	3490	53° 52′	
			2° 30′
15	3400	56° 22′	
			2° 50′
17	3300	59° 12′	
			3° 10′
19	3200	62° 22′	
			4° 0′
21	3100	66° 22′	
23	2928	71° 18′	4° 56′
Oc-tob.	In the year	1532	
3	3628	60° 57′	
			11° 30′
14	3320	72° 27′	
			5° 10′
19	3250	77° 37′	
			12° 20′
31	3160	89° 57′	
			7° 15′
Nov. 8	3197	82° 48′	

Date	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
Nov.	In the year	1577	
13	3534	57° 4′	
			8° 30′
19	4000	48° 34′	
			6° 30′
25	4500	42° 4′	
			5° 20′
Dec. 1	5000	36° 44′	
			4° 0′
7	5500	32° 44′	
			3° 10′
13	6050	29° 34′	
			2° 40′
19	6600	26° 54′	
			2° 20′
25	7200	24° 34′	
			2° 0′

Date	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
31	7750	22° 34′	
			1° 38′
Jan. 6	8302	20° 56′	
Oc-tob.	In the year	1585	
10	6587	81° 26′	
			5° 40′
14	6700	75° 46′	
			5° 10′
18	6900	70° 36′	
			4° 50′
22	7100	65° 46′	
			4° 30′
26	7400	61° 16′	
			4° 5′
30	7700	57° 11′	
			3° 45′
Nov. 3	8040	53° 26′	
7	8450	49° 56′	3° 30′
11	8870	46° 38′	3° 18′

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Date	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
Febr.	In the year	1590	
23	4037	60° 0′	
			6° 0′
26	4340	54° 0′	
			5° 10′
Mart. 1	4640	48° 50′	
			4° 20′
4	4950	44° 30′	
			2° 20′
6	5208	42° 10′	

[619] Arrangement of the table. The table of p. 809 continues at the top of this page under the same head, again in two halves side by side in one frame; the left half (1590, 1607) is given first, then the right half (1618, 1652). The columns are as on p. 809; here both halves head the last column with the word Sole, and the right half's angle column is headed Gr. and M. As on p. 809, each motion figure follows the interval between two dates: each year prints one motion figure fewer than it has dates. Most stand between the lines of the dates and are given rows of their own; those printed level with the line of a date stand on that row (left half: 10, 16, 19 and 25 in 1607; right half: 24 and 28 December 1618, and 8 January in 1652). The left half ends with blank ruled space below it. All figures were read at zoom 3.

Date	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
Septemb.	In the year	1607	
26	4764	31° 36′	
			0° 40′
28	4700	32° 16′	
			1° 0′
Octob. 1	4600	33° 16′	
			1° 20′
4	4460	34° 36′	
			2° 0′
7	4240	36° 36′	
10	4000	39° 6′	2° 30′
			3° 0′
13	3750	42° 6′	
16	3500	45° 46′	3° 40′
19	3230	50° 38′	4° 52′
			8° 0′
22	2920	58° 38′	
25	2660	69° 38′	11° 0′

Date	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
Decemb.	In the year	1618	
1	3139	41° 45′	
			6° 0′
4	3580	35° 45′	
			5° 0′
7	4060	30° 45′	
			3° 45′
10	4550	27° 0′	
			2° 45′
13	5020	24° 15′	
			2° 10′
16	5500	22° 5′	
			1° 50′
20	6100	20° 15′	
24	6660	18° 15′	2° 0′
28	7240	16° 30′	1° 45′
			1° 25′
Jan. 2	8020	15° 5′	
			1° 10′
7	8600	13° 55′	
			0° 50′
12	9200	13° 5′	
			0° 40′

Date	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
17	9810	12° 25′	
De-	In the year	1652	
cemb.			
14	5337	80° 14′	
			3° 10′
17	5400	77° 4′	
			2° 50′
20	5450	74° 14′	
			2° 40′
23	5510	71° 34′	
			2° 20′
26	5600	69° 14′	
			2° 40′
30	5700	66° 34′	
			2° 5′
Jan.	5810	64° 29′	
2			
			1° 55′
5	5920	62° 34′	
8	6023	60° 50′	1° 44′

[Margin: In quibusdam Cometis incrementa motûs, variationem motûs Cometæ ex Sole ſequuntur.] *In some comets the increases of motion follow the variation of the motion of the comet from the Sun.*

From this it plainly becomes evident that in some comets indeed, and in fact in most, the increase of speed and slowness from the beginning right up to the end depends above all on the variation, or difference, of the motion of the comet from the Sun. For in the comet of the year 1585 the difference of that motion was nearly 2°, and hence the difference of the motion of the comet in its trajectory was observed to be only 5 semidiameters of the Earth (as the table above, p. 687, confirms). Again, in the comets of the years 1532 and 1590 the difference of the motion of the comet from the Sun was about 4°; therefore the difference of the motion of the comet in its trajectory was recorded as 22 or 42 semidiameters of the Earth. Next, in the comet of the year 1618 the difference of the motion of the comet from the Sun amounted to 5 or 6 degrees; for this reason the difference of the motion in the trajectory came to 78 semidiameters of the Earth. Likewise in the comet of the year 1607, just as the difference was the greatest of all, namely 10 degrees, so too the difference of the motion in the trajectory grew to nearly 170 semidiameters of the Earth. From this someone might conjecture that some proportion lay hidden here. But since other comets are entirely at odds with these: for example, the comet of the year 1577, whose difference of motion from the Sun was found to be 7 degrees, should certainly have shown a greater difference of motion in its trajectory than those whose difference of motion from the Sun was found to be 4°; but we observed plainly the contrary, since its difference of motion in the trajectory was found to be

only 15 semidiameters of the Earth. Similarly, in the comet of the year 1652 the discrepancy of the motion from the Sun was only 2 degrees; whereas the difference of the motion in the trajectory up to 40 semidiameters of the Earth reached. From this it is shown fully, again and again, that still other reasons, without any doubt, lie hidden here, which are to be investigated more fully below.

[Margin: An diverſ[[á/â]] Trajectoriæ à Sole Terrâq; diſtantia diverſitatem aliquam motûs inducat.] *Whether a different distance of the trajectory from the Sun and the Earth induces some diversity of motion.*

To some, indeed, it might seem that a different distance of the trajectory, and so the distance of the comet from the Sun, could induce some notable diversity of motion. But when we contemplate all the comets and their diagrams carefully, that very distance does nothing whatever in this respect. Namely, even if the trajectory of some comet extends nearer to the Sun than that of some other, the motion of the former comet is nevertheless by no means swifter than that of the latter, even though it sometimes does in fact so happen by some chance, for quite other causes. For in some comets, where the orbit is more remote from the Sun, the motion is more rapid than in the others, where the trajectory is nearer.

[Margin: Differentia intervalli Cometæ à Sole, nec motui nec incremento velocitatis vel quicquã confert.] *The difference of the distance of the comet from the Sun contributes nothing at all either to the motion or to the increase of speed.*

So that you may grasp this the more correctly and clearly, curious reader, it seemed good at the same time to bring into the preceding table the distance of each comet from the Sun, computed with due diligence, so that it may thus be clear to everyone that the difference of the distance of the comet from the Sun contributes nothing at all either to the motion or to its proportion of speed in the trajectory. And yet it cannot be denied, as was set out in the sixteenth theorem of this book, p. 640, that the comet, the nearer it approaches the Sun in its trajectory, seems to intensify its course the more; so much so that the trajection is swiftest when the straight line drawn from the Sun to the comet is perpendicular to the trajectory itself. For at that place the comet is always nearest to the Sun.

[Margin: Cometa, quò propiùs Soli, non ſemper eò velocior exiſtit.] *A comet is not always the swifter, the nearer it is to the Sun.*

But these things are to be understood of any comets considered by themselves, when the different distances of one comet in its own trajectory alone are taken: there, I say, the said theorem holds, but by no means when different comets are compared with one another.

[Margin: Præcipua ratio, cur hujus vel illius Cometæ curſus tardior vel velocior exiſtat.] *The principal reason why the course of this or that comet is slower or swifter.*

Therefore, having carefully considered and investigated all these things, it seems to me that the principal causes why the motion of this comet rather than

of that one is more intense or more slack (if it is considered in itself over its whole duration) are, first, the matter and shape of the comets, and second, the motion impressed on the comets from their very beginning: according to these properties, I say, one comet turns out swifter and more sluggish than another.

[Margin: Materia Cometarum motui haud parùm contribuit.] *The matter of comets contributes not a little to motion.*

Indeed, no one will readily deny that matter contributes very greatly to motion. For it is implanted by nature, and is a solid principle, as we established on p. 647 of this Book IX, that the denser and more solid bodies are, the more apt they are for motion. Therefore any denser body is set in motion more quickly and more swiftly than a rarer and less solid one. This is so very well known that it needs no further demonstration. For who is so unskilled as not to know that the motion of a falling stone, or of a thrown one, is much swifter and more vehement than that of some small piece of wood of the same shape, or of some ball of wool or some other rarer and thinner matter, lightly rolled together or massed together?

[Margin: Hoc ipſum Cometâ 1618,nec non aliis quibusdam haud obſcurè probatur.] *This very thing is proved, and not obscurely, by the comet of 1618, and also by certain others.*

Accordingly, the denser, more compact and more solid a comet is as regards its matter, the more swiftly and vehemently it is carried in its trajectory; but the rarer and thinner the matter it consists of, the more sluggishly and laboriously it moves. All this can be confirmed by the comet of the year 1618, which at the beginning, as we have seen from its calculation, when it still consisted of a dense body and of only one or two more compact nuclei, and a fairly swift course in the trajectory 200 semidiameters of the Earth, traversing [them] in one day, it kept up; but towards the end, when the matter was already growing rare and dissolving, it proceeded with a far slacker motion. The comets of 1652 and 1661, and all the others too, likewise confirm this clearly: namely, where they were brighter, more luminous and more compact, in a more solid constitution, there they were always most rapid; on the other hand, when they were of a paler colour and duller light, their matter, that is, being thinned and dispersed little by little, more and more, they were never observed to be other than much slower. So it is clearer than the light of noon, and the thing speaks for itself, that in proportion as the matter, more compact and rarer, is dissolved and dissipated now more quickly, now more slowly, the motion turns out now swifter, now slower.

[Margin: Figurâ quoq́; corporis Cometici, motui plurimùm confert.] *The shape of the cometary body, too, contributes very greatly to motion.*

Next, not a little seems also to be added to this matter by the shape of the cometary head. For in proportion as the disc is narrower or thinner, the comet is always more apt and more inclined to motion, as we demonstrated openly near the beginning of this Book IX, and as the axioms also show clearly, especially the first, second and fourth. For a thinner orb passes through and penetrates

the air more readily than some cubic body, since it feels less resistance and so is retarded less by the aether. Indeed, bodies move the more swiftly, the more easily they can and the less they are impeded. Moreover, a greater counter-pressure [obnixus] produces a more difficult, and consequently also a slower, motion.

[Margin: Motus impreſſus,ſeu impetus primus præcipua cauſa eſt diverſæ velocitatis.] *The impressed motion, or first impetus, is the principal cause of differing speed.*

But the chief cause of all, in my judgement at least, is the impressed *motion of the comet*. For that impelling force, or moving power, or first impetus, is greater or more vehement now in this comet, now in that: greater, understand, in comets equal in shape and matter which issue from a more ample atmosphere than in those which issue from a narrower one.

[Margin: Cometæ, qui ex amplioribus Atmoſphæris prodeunt, velociores ſunt.] *Comets that issue from more ample atmospheres are swifter.*

Similarly, the moving power is far stronger in comets which spring forth around the equator, under a great circle, than in those which spring forth nearer the pole, under some smaller circle. For, as was clearly demonstrated on p. 645 of this book, larger circles are moved more swiftly by an equal power, and move loads; moreover, the longer the lever, the greater the power. This is likewise to be understood of more ample atmospheres.

[Margin: Celerior & rapidior Atmoſphæra, concitatiorem etiam motum Cometis imprimit; præſertim ſi circa ejus Æquinoctialem ejiciuntur.] *A swifter and more rapid atmosphere also impresses a more rapid motion on comets, especially if they are thrown out around its equinoctial.*

Finally, that motion is made much more vehement and rapid still in comets that are projected from a more rapid atmosphere, one driven round in a circle more frequently. For in such a vaporous orb the cometary matter obtains a more notable impetus for moving itself, just like a stone in a sling: the longer the sling is, and the more swiftly and often it is whirled round, the more excellent the force the stone acquires as it leaves the sling. For it has been proved from mechanics, in its proper place, that the more extended that which runs from the centre is, the more quickly it is moved; and the more something is rotated, the greater the force and impression of moving itself it acquires. Hence, as long as that motion of whirling and circling lasts, so long does that endeavour last, and it is as it were renewed at each moment, as we deduced more fully on p. 645. Last of all, there is the further point that in those comets which spring forth nearer the equator the speed is increased, or the motion accelerated, more strongly by reason of the atmosphere, as we likewise touched on a little before. For since the motion there is more rapid than around the poles, it follows that the nearer to the pole, the weaker and slacker the impelling and extruding force. Moreover, just as all the remaining circles of any sphere are smaller than the great circle, or equator, so too the motion, in the same proportion as the circles

stand to one another, is greater or smaller, more intense and swifter, slacker and slower.

[Margin: Non univerſæ Planetarũ Atmoſphær[[a/æ]] æq́; velociter, tum æquali temporis ſpatio circumgyrationes ſuas peragunt.] *Not all the atmospheres [?] of the planets perform their circumgyrations equally swiftly and in an equal space of time.*

That all the planets, and indeed all the fixed stars too, rotate about their own axis, as we established in its proper place, is now no longer in any doubt. Meanwhile, however, as we readily conjecture, one planet with its atmosphere performs more and swifter circumgyrations than another, in a shorter interval of time, or repeats its period more often in an equal time.

[Margin: Sol 26 vel 27 diebus unam periodum ſuæ vertiginis abſolvit.] *The Sun completes one period of its whirling in 26 or 27 days.*

For the Sun, as has been ascertained, rotates with its atmosphere in 26 or 27 days. In the remaining bodies, it is true, it has not yet been detected as clearly in what space of time they revolve about their centre; yet it seems most probable that not all the aethereal bodies are turned round equally and in the same time. Rather, just as the Earth (which, in the opinion of the Copernicans, likewise merits by no means the lowest place among the remaining planets) is moved round in a circle on its axis in the space of 24 hours, and the Sun in 27 days, as I said just now, more or less, so too all the others complete their periods of whirling in their own way, with a fitting speed: now that one in a shorter time, more and swifter ones, this one in a longer space of time, fewer and slower ones. Perhaps they accomplish their whirlings in proportion to the size of each body and its atmosphere, or by some other proportion and ratio still unknown to us and undetected.

But however that may be, it makes no difference at all on this occasion whether this or that planetary atmosphere is turned round in so much or in some other space of time, and with what speed of course each one is turned round. It is enough only to know and to grant that most atmospheres are driven round in a circle with the most diverse motions, just as happens with the planets, which do not all complete a like period of revolution in their orbit in an equal interval of time.

[Margin: Quinam Cometæ ſint omnium velociſſimi, & quinam tardiſſimi.] *Which comets are the swiftest of all, and which the slowest.*

From this it follows that comets which issue from a more ample atmosphere, one driven round more frequently and more vehemently, and from around its equator, with a thinner and more erect disc, and which are composed of more compact, denser and more tenacious matter, exert a more rapid and quicker motion than those which issue from some narrower atmosphere, one led round in a circle more slowly and sluggishly, from somewhere under its poles, which are constituted of rarer and more fluid matter, and which have a thicker, more oblique and more inclined disc.

[Margin: Cometas Solares eſſe admodum veloces.] *Solar comets are very swift.*

And from this we judge it not unreasonable that solar comets, generated in the most ample and vast atmosphere of the Sun (which without doubt exceeds the atmospheres of all the remaining planets in due proportion, as the bodies exceed one another), and consisting for the most part of a more solid and compact body (and therefore also more luminous, more splendid and more stable than the rest), are in truth, unless my opinion deceives me, far more rapid still, or swifter in motion, than the others, which have arisen from any other vaporous orb. Of these we have a strikingly illustrious example in the comet of the year 1618.

[Margin: Quomodo motus Cometarum a[[c/e]]celeretur.] *How the motion of comets is accelerated [?].*

For the rest, if there is further added to, and befalls, some comet of that kind some very great variation of the inclination of the disc, and of the angle of the Sun's ray with the trajectory, and also of the motion of the comet from the Sun, then that comet, which by its own nature already enjoys a very swift motion from the beginning, is made much swifter still, and its course is spurred on and accelerated more readily; in proportion, namely, as the inclination of the disc to the tra- jectory becomes straighter and diminishes, and the comet proceeds nearer to the perpendicular; but above all when, at that place of its path, it attains its maturity at the same time. Then, I say, such a hairy star can be moved in its orbit with the swiftest course, if so many causes concur.

[Margin: Nullus Cometa alteri quà velocitatem ſimilis eſt.] *No comet is like another as regards speed.*

But since it very rarely happens that all these causes promoting motion flow together in one cometary body at once and at the same time, but it is more probable that now this one, now that one is lacking, one comet is therefore now swifter, now slower than another, so that hardly any is equal to another in every respect as regards motion: namely by reason, as we have said, of the matter, shape and constitution of the body, of the impelling power, of the distance of the comet from the Sun, and of the inclination of the disc. From this it is easily seen why some comets are slower, or swifter, at the beginning, others midway along their path, and others again towards the end.

[Margin: Velociſſimi ſunt Cometæ initiò, qui circa verticem parabolæ prodeunt.] *Those comets are swiftest at the beginning which issue around the vertex of the parabola.*

But of all comets, those are of the most rapid motion at the outset which come into our sight around the vertex of the parabola or hyperbola, that is, around the straight line falling from the Sun onto the trajectory, if they attain their greatest strength there at the same time; and shortly afterwards their matter again grows rare and thins out.

[Margin: Quinam Cometæ ab initio ſint tardiſſimi.] *Which comets are slowest at the beginning.*

Conversely, comets are slowest of all at the beginning when from the outset they are as far as possible from the perpendicular, and at the beginning are

of a rarer body, but afterwards, gradually, while they are carried towards the perpendicular and the Sun, that is, to the vertex of the parabola of the line of their path, they also grow thicker. Again, around the middle the most rapid are those comets, namely, that describe an entire section of a parabola, above all if at the same time they are at their most vigorous and flourishing there.

[Margin: Nullus omnium Cometarum in medio ſui itineris tardiſſimus eſt.] *No comet of all is slowest in the middle of its path.*

Here, however, I would have you note well that no comet can ever arise which is slowest in the middle of its path and appearance (as regards, that is, its true motion in the trajectory). For even if it begins its course from the perpendicular, its motion nevertheless necessarily decreases because of the angle of inclination of the disc; likewise, although it enters on its motion from the extreme point of the parabolic line and hastens towards the perpendicular, that is, towards the vertex, its motion in turn increases. Indeed, supposing the comet describes an entire conic section, it is none the less finally [recte: deniquè] made slower in motion, in whatever direction and however far it may also proceed. From this arises this axiom: that no comet can be the slowest of all in the middle of its path and appearance, as indeed [it can be] the swiftest.

[Margin: Cometarum incrementa & decrementa progreſſionis à nullâ proportione dependent.] *The increases and decreases of the progression of comets depend on no proportion.*

Finally, these things show abundantly that the motion of progression, the increase as much as the decrease of speed, can by no means occur equally, nor always according to some fixed proportion in all comets, as indeed happens with certain other things that are set in motion, or that fall. Indeed, though you suppose an arithmetical, square or cubic progression, all the labour is nevertheless wasted, since it can be bound by no laws at all in this respect, so that all comets would always exert a motion like to itself at the same trace of place and time; rather, for the reasons stated above, now one comet at the beginning, another towards the end, is found now slower, now swifter in its course: which was what was to be investigated.

[Margin: Comparatio inſtituitur inter motum MacularumSolariũ & Cometarum.] *A comparison is drawn between the motion of the solar spots and that of comets.*

In the last place, let us also compare this motion of comets with the motion of the solar spots, and, as we clearly showed in Book VII, the generation and corruption of each of the two phenomena, by a close bond between them are joined to one another; so now we shall likewise demonstrate in what respects they agree entirely as regards motion, and in what respects, again, they differ.

Comets are rightly compared with the spots, as regards motion, in a twofold respect: first, as regards true motion; then also as regards apparent motion.

[Margin: In motu proprio maximè differunt.] *In proper motion they differ most.*

In the former, namely proper motion, comets and spots disagree most. For the proper and true motion of the spots around the Sun is almost always regular, if, that is, you except the motion of augmentation and diminution, of accretion and dilatation.

[Margin: Motus Macularum eſt regularis.] *The motion of the spots is regular.*

1. For the paths of the spots are equal at the same time of year and on the same day. 2. All the spots proceed from the eastern quarter of the Sun to the western, and indeed almost equally swiftly, if they are found at the same time of year in equal latitude.

[Margin: Omnes Maculæ motu ſuo deſcribunt ſimiles ductus..] *All the spots describe similar courses by their motion.*

3. All the spots describe similar courses of lines by their motion at the same time of year, in this way: every half-year, when the Sun (or rather the Earth) is near the beginning of Cancer and of Capricorn, they all proceed in a straight line. Then, through the space of half a year, they bend their paths obliquely towards Auster [the south], while the Sun is in Aquarius, Pisces, Aries, Taurus and Gemini; but when the Sun travels through Leo, Virgo, Libra, Scorpio and Sagittarius, they turn their course towards Aquilo [the north]. So in the motion of the spots an admirable dissimilar equality, and an unequal similar variation, is observed.

[Margin: In quibus inter Cometas & Maculas, quoad motum proprium, diſconveniat.] *In what respects comets and spots disagree as regards proper motion.*

But in comets we find exactly the contrary. 1. For neither the paths nor the proper daily motion in the trajectory are entirely equal in the individual comets, even at the same time of year and in the same place of the heavens; rather, all of them, as many as have appeared, have been most diverse among themselves in this respect, so that hardly ever is one like another, unless by chance. 2. Nor do comets always set their course from east towards west, much less do they keep fixed paths or fixed periods in respect of their proper motion, in the manner of the spots. Rather, just as they first arise in every part of the heavens, and take their way now in this direction, now in that, according as they are projected from this or that planetary atmosphere, at this or that place of it, under this or that inclination, so they are moved towards this or that quarter, now more slowly, now more swiftly, in accordance with the nature of the matter they consist of and of the vaporous orb from which they were born, as we have set out more fully above. We have therefore rightly asserted that the true motion of comets in their orbit in no way at all agrees with the motion of the solar spots.

[Margin: Quâ motum apparentem etiam maxima diverſitas Cometis cum-Maculis intercedit.] *As regards apparent motion too, there is the greatest diversity between comets and the spots.*

Likewise in apparent motion the same dissimilarity is also found. For all the spots, as regards this motion, are always swiftest in the middle of the Sun's disc, at the same place of the sky, that is, or time of year; but around the edges of the

solar disc they never fail to be found slowest. Then, too, they exert an equal and uniform motion, at similar times, that is.

[Margin: Macularum motus ut creſcit ad Solis medium, ſic rursùs decreſcit.] *As the motion of the spots increases towards the middle of the Sun, so it decreases again.*

[Margin: Maculæ nunquam ſunt ſtationarii & retrogradi.] *The spots are never stationary and retrograde.*

Moreover, just as the motion of all the spots always increases from their first entry as far as the centre of the Sun, so in almost the same proportion it then decreases again; so that they never rush headlong in their motion, nor accelerate it beyond the accustomed measure, now more, now less; nor do they make stations, nor become retrograde, but they continually proceed strictly straight on. On the contrary, how great an anomaly, and how very diverse a diversity and inequality, in all these things, with comets and their apparent motion is found!

[Margin: Contrarium plan[[è/é]] in Cometis deprehendimus.] *We find exactly the contrary in comets.*

Indeed, not a single comet ever arises that is entirely like and equal to some other in every respect, as we have recalled to mind more than once. For one is more rapid or slacker in motion now from its first rising, now in the middle of its path, now towards the end. Sometimes one comet completes scarcely one degree, more or less, in one day; on another, following day, it in turn accomplishes more than 10, 20, 30, indeed 40 degrees, as was observed in the comet in the year 1472 and also in certain others. They are found now direct, now stationary, now retrograde, advancing now according to the order of the signs, now against it; to say nothing of the very many remaining varieties and vicissitudes, which it would take too long to enumerate here. So nothing whatever is truer than that the motion of comets, the proper motion in the trajectory as much as the apparent, differs utterly from the motion of the spots; although in generation and corruption, and in all the remaining affections, spots and comets are most closely joined to one another.

[Margin: Quâ ratione rursùs Cometæ cùm Maculis optime concordant.] *In what way comets again agree very well with the spots.*

But truly, if we consider the matter a little differently, and grant at least one single thing in each motion, proper as well as apparent, then they again agree very well in almost everything.

[Margin: Maculæ Solares Atmoſphæram nunquam exeunt.] *The solar spots never leave the atmosphere.*

First, you must know that all the spots are generated in the atmosphere itself near the Sun, persist in it, and never in any way leave it. Rather, they complete their motion in that same atmosphere, not indeed from some impressed impetus, as happens with comets, but from the agitation and circumgyration of the solar body and of its vaporous orb, which completes its period within 26 and 27 days.

[Margin: Vnde motus Macularum proficiſcatur.] *From where the motion of the spots proceeds.*

For just as the body of the Sun is driven round in a circle about its axis, so too it carries the surrounding aether, namely the atmosphere, along with it in the same interval of time; and hence the thicker solar evaporations, from which the spots are generated, exert no evident and peculiar motion of their own (except the one by which they are continually carried from the centre of their atmosphere towards the outer parts of the periphery).

[Margin: Cur motus omnium Macularum tam regularis & conſtans ſit ?] *Why is the motion of all the spots so regular and constant?*

Rather, all the motion that occurs in the spots, the apparent as much as the true, belongs solely to the atmosphere of the Sun. Since that atmosphere is carried in a continuous circular motion, in the space of about 27 days, those effluvia too (if any are given, and come together into so great a body that they can be seen by us, and are capable of motion) are at the same time rotated round together with the said atmosphere. From this it follows that, although the spots are fluid and perishable bodies, their motion is nevertheless at all times equal and most constant, without any diversity in all of them, at the same time, that is, when the Earth returns again to the same signs of the zodiac. For this reason, too, the apparent motion of the spots becomes slower the nearer it is to the limb of the Sun, and more rapid the nearer it is to the centre of the Sun's disc; and from this all the spots always grow slender around the limb, and appear thinner than around the centre. Finally, the motion in all the spots without distinction never fails to be carried towards the west, beginning from the east.

[Margin: Maculæ nullum fer[[è/é]] motũ proprium, ſed ſolummodò apparentem exercent.] *The spots exert almost no proper motion, but only apparent motion.*

For the motion is not implanted in the spots by nature, and real, but [arises] solely from the carrying of the atmosphere; and so in fact they possess almost no notable proper motion, but are nearly immobile, at the place of the solar disc where they are produced.

[Margin: Quamdiu Cometæ in ſuis Atmoſphæris hærent, omninò cum Maculis ſunt concordes.] *As long as comets remain in their atmospheres, they agree entirely with the spots.*

If, therefore, we weigh comets and their motion only so far as they remain in the atmosphere in which they were first born and in which the cometary matter was initially coagulated, I say that the principle is plainly one and the same (that is, as long as they linger in the atmosphere) in comets as in spots, with respect to the proper motion as much as the apparent. For, as we have pointed out more than once, since all the planetary atmospheres turn about their axis in a fixed period, it cannot be otherwise than that the cometary matter too (which otherwise exerts scarcely any detectable motion of its own) is moved round in a circle together with its atmosphere. If, then, it were in any way granted to view the planet at such close quarters, with that small, newly coagulated matter in its

atmosphere, as indeed falls to our lot with the matter of the spots under the Sun, we would certainly detect like phenomena in any of them, with respect, that is, to the apparent motion: provided, namely, that the atmosphere in which that cometary matter then dwelt were of the same vastness as the vaporous orb of the Sun, and reproduced a similar whirling, both in period and in velocity. But if that atmosphere enjoyed a dissimilar and different circumgyration, the motion of the comet would nevertheless be similar and equal to the motion of the spots in a certain proportion. Accordingly, all comets produced in this way in similar atmospheres would appear always to exert a similar motion.

[Margin: EtiamComet[[æ/e]] in Atmoſphæris circa limbum gracileſcunt atquè tardiùs moventur.] *Comets too grow slender around the limb in their atmospheres, and move more slowly.*

[Margin: Cometæ in Atmoſphærâ conſtituti ſemper eandem versùs plagam feruntur.] *Comets placed in an atmosphere are always carried towards the same quarter.*

For before the comets left the atmosphere, (1) they would move more slowly around the limb of that planet, but more swiftly around the centre; (2) they would always show an equal course at the same times of the year (with respect to the Earth); (3) around the limb they would constantly grow slender and be compressed, but around the centre of the planetary disc they would dilate and spread apart, exactly like the solar spots; (4) all of them, too (those comets, that is, produced in the same atmosphere), would at all times hold a similar course towards the same quarter, the one to which the motion of the atmosphere's whirling tended; and indeed from east towards west, as is customary for the solar spots and for all the remaining heavenly bodies (as regards the gyratory motion). So between comets, as long as they persisted in the atmosphere, and the solar spots there would be no difference at all, nor could any ever be detected. But only up to that point, I say, until the comets left their atmosphere, or native soil, which I would like you to note well.

[Margin: Cometæ quam primùm Atmoſphæram egrediuntur,diverſis motibus ſubjiciuntur.] *As soon as comets leave the atmosphere, they are subjected to different motions.*

For as soon as they are expelled from the atmosphere and go out into the free aether, and a proper motion has been impressed on them, this motion varies enormously according to the matter and shape of the body, the size of the atmosphere and the diversity of its whirling, and also [as] the comets are carried far from or close to the Sun. For these reasons, as we have shown in its place, one can almost never be like another in anything whatever.

[Margin: Idem planè Maculis eveniret, ſi Orbem Solis vaporoſum exirent.] *Exactly the same would happen to the spots if they left the vaporous orb of the Sun.*

Likewise, if it happened that the spots, like comets, went out of their vaporous orb (which, however, I am convinced is scarcely possible, because of the thickness of their matter), those spots would certainly imitate exactly the same

propensity and the same affections as the cometary matter already expelled into the aether.

[Margin: Quâ ratione ergo Cometæ cum Maculis conveniant, & quâ diſcrepent.] *In what way, then, comets agree with the spots, and in what way they differ.*

And hence it can be recognized most evidently that the motion of the solar spots is indeed dissimilar to the motion of comets, or rather appears so, while the spots are considered in the atmosphere, but the comets mostly outside it. But if, on the other hand, the spots as much as the comets within the limits of the atmosphere; indeed, although ev- en outside the vaporous orb they are compared with one another and together, they would agree entirely with one another in everything.

[Margin: Quilibet Planetarum alit nonnunquam ſuas Maculas.] *Each of the planets sometimes nourishes its own spots.*

Moreover, if we weigh the matter somewhat more deeply still, we shall find that each and every comet, as long as it lingers in its native atmosphere, is nothing but pure and simple spots of this or that planet from which they were then born, producing exactly the same phenomena, though according to the diversity of each atmosphere. Indeed, if it could be done, and telescopes sufficiently capacious and powerful for discerning those things were supplied to us (as I hope, by God's favour, will at some time be built in due course from hyperbolic sections, by us or by posterity, with success), there is no doubt that these and similar phenomena would be distinctly noticed in the remaining atmospheres of the planets too, just as around the solar spots.

But so that we do not linger on these things any longer and indulge our speculations too much, let us return to the true proper motion in the trajectory, so that what still remains, and must necessarily be said, may be brought out.

[Margin: Quâ velocitate Cometæ feruntur motu proprio, quando omnium ſunt velociſſimi.] *With what velocity comets are carried by their proper motion when they are the fastest of all.*

[Margin: Motus Cometarum, quam rationem habeat ad motum Planetarum.] *The motion of comets: what relation it has to the motion of the planets.*

Since, therefore, it has been shown at length on page 689, and here and there elsewhere, that the proper motion of all comets in the trajectory is plainly unequal, for reasons given in their place, the question is now asked further: with what speed comets are carried when they are in fact the fastest of all, or the slowest; and then how their motion stands in relation to the other planets and to their matter. Since these matters, as far as we have discovered, have not yet been touched upon by anyone, even lightly, the duty of our office now demands that we weigh them somewhat more carefully and more precisely.

As regards, then, the velocity of the cometary motion, I think it must be impressed once again that here we have to deal not with the apparent motion, about which we have already discoursed at sufficient length in this Book and elsewhere, but with the true proper motion in the trajectory: namely, of how

great a velocity or slowness it actually is when it is the most rapid or the slowest of all, and then how variously diverse it has been observed to be.

[Margin: Motus Cometarum tam ex Terrâ quàm Sole conſiderandus eſt.] *The motion of comets is to be considered from the Earth as much as from the Sun.*

If this motion is to be examined properly, however, it must be considered in two ways: first, how it is viewed from the Earth; then also how it is viewed from the Sun, since the matter is very different. Indeed, it is to be heeded that a comet observed from the Earth sometimes appears much faster and slower, because of the annual motion of the Earth, than if it is noticed from the Sun.

[Margin: Motus Terræ annuus Cometis diverſitatem parit.] *The annual motion of the Earth produces diversity in comets.*

For when the comet is retrograde, against the order of the signs [contra ſ. ſ.], its motion seems much more rapid than when viewed from the Sun, since the Earth is at that time driven in the opposite direction, and indeed with a very swift motion, as we shall shortly explain at greater length. But when the comet advances in the order of the signs together with the Earth, towards the same quarter, its motion certainly appears far slower; so that the course of the comet, although it is much quicker than the motion of the Earth, nonetheless necessarily appears slower, this motion, namely, being subtracted from that one.

Therefore it seems better that the motion of the comet be considered only from the Sun, where neither the annual motion of the Earth nor any other extraneous [motion] has any place or can contribute anything; there, I say, it will be possible to find out correctly with what velocity or slowness comets are carried as regards their proper motion? This will now have to be investigated. For just as all the other wandering stars [Errones], the ordinary and coeval, regard the Sun with their orbit according to fixed laws and follow it, so too all comets, like extraordinary and temporary planets, obey the Sun in their own way with their trajectory when they leave their atmosphere — as we have not only already said and shown in part, at length, in this Book, but as can now also be demonstrated more clearly in this place without great trouble.

[Margin: Sicuti Planetæ primarii Solem pro centro agnoſcunt,ſic etiam-Cometæ ſuo modo eum reſpiciunt.] *Just as the primary planets acknowledge the Sun as their centre, so comets too regard it in their own way.*

Above all, since everything that bears on the matter itself has already been computed by exact calculation and entered in the table on page 689. In it you will have the proper motion of nine comets for any days of their appearance: that is, how it behaved in the trajectory, and what difference was found in that motion.

[Margin: Cometa 1472 aliorum omniũ debitè obſervatorum curſu fuit tardiſſimus.] *The comet of 1472 was the slowest in its course of all the others duly observed.*

You see, therefore, that the motion of Regiomontanus's comet in the year 1472 was, at its beginning, on 14 January, the slowest of all the others, since in one day it flew through only 33 semidiameters of the Earth. In slowness it

was followed by the comet of the year 1532, which on 8 November covered only 47 semidiameters of the Earth; but all the rest, as is plain to anyone, were much faster, as was our comet of the year 1652 too: for where it was proceeding at a slower pace, namely on 8 January of the year 1653, it accomplished 72 semidiameters of the Earth.

[Margin: Cometa 1607 fuit inter reliquos velocisſimus.] *The comet of 1607 was the fastest among the rest.*

Again, of all the others the comet of the year 1607 was the most rapid, towards its end, namely on 25 October, since it traversed 220 semidiameters of the Earth, likewise in the space of 24 hours. Next to it came the comet of the year 1618, which on 2 December ran through 198 semidiameters of the Earth; but all the others were somewhat slower, even where they were otherwise observed at their swiftest course.

[Margin: Motus diurnusCometarum tardior, quot Semid.T. conſtet.] *The slower daily motion of comets: how many semidiameters of the Earth it amounts to.*

From this one may judge clearly enough, at least as far as these nine comets allow, that none of them (if, that is, they are considered from the Sun) has been found slower than 33 semidiameters of the Earth, and none faster than 220 semidiameters of the Earth, even where they quickened their pace the most. But if we set aside the comet of the year 1472 as suspect in this respect (since it was observed only roughly) and decide the matter from the rest alone, then none will have been slower than 47 semidiameters of the Earth.

[Margin: Quot Semid. T. alius Cometa alio nonnunquam ſit velocior.] *By how many semidiameters of the Earth one comet is sometimes faster than another.*

The difference, therefore, lies between 47 and 220, and is 173 semidiameters of the Earth: that is, the amount by which one comet has so far been found faster or slower than another; what will happen in the future, time will tell. Meanwhile, so that you may have the slowest and the fastest motion of all those comets at a single glance, it seemed best to take it from the table above and set it out in this one appended here.

[Margin: Nonnullorum Cometarum tardisſimus & velocisſimus motus.] *The slowest and fastest motion of some comets.*

Comet of the year [Cometæ anno]	1472	1531	1532	1577	1585	1590	1607	1618	1652
Slowest motion [Tardisſimus motus]	Sem. T. 33	Sem. T. 84	Sem. T. 47	Sem. T. 103	Sem. T. 156	Sem. T. 154	Sem. T. 52	Sem. T. 120	Sem. T. 72
Fastest motion [Velocisſimus motus]	100	150	71	118	161	176	220	198	110

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Finally, we shall convert these semidiameters of the Earth into German miles, so that it may at the same time be clear how many miles the comets covered in one hour, in a single minute and in a second. Assuming, therefore, that the slowest comet traversed 33 and the fastest 220 semidiameters of the Earth, it follows from our hypothesis, given a mean distance of the Sun from the Earth of 5127 semidiameters of the Earth, that the motion is exactly the same as we have entered in the small table that follows.

	In one day, German miles [Vno die Mill. Germ.]	In one hour, German miles [Vnâ horâ Mill. Germ.]	In one minute, German miles [Vno Minuto primo Mill. Germ.]	In one second, German miles [VnoMinut.ſe-cund. Mill. Germ.]
When the comet was slowest, 33 semidiameters of the Earth [Cometa cùm fuerit tardisſimus 33 Sem. T.]	28380	1182	20	1/[?]
When the comet was fastest, 220 semidiameters of the Earth [Cometa cùm fuerit velocisſimus 220 Sem. T.]	189200	7883	131	2 11/60

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[Margin: Quot mill. Cometa unico minuto primo conficiat.] *How many miles a comet covers in a single minute.*

I readily admit, indeed, that to some people not only this proper motion but consequently our whole hypothesis of comets may become suspect on that account, since in this way comets are allowed to fly through 131 miles in a single minute. I admit, moreover, that this swiftest motion of the comets, as indeed cannot be denied, turns out much faster than the sailing course of ships,

[620] Arrangement of the page. The table stands across the full width of the text block after the sentence that announces it, with the side-note beside it in the margin; it has no caption of its own. The stub labels (Cometæ anno, Tardisſimus motus, Velocisſimus motus) are set in italic, each of the last two in two lines, joined here. In the row of the slowest motion each cell prints the unit Sem. T. (semidiameters of the Earth) on its upper line and the value under it; in the row of the fastest motion the cells print the value alone, with a blank line under it. The table is ruled with vertical rules between the columns and horizontal rules at the top, under the years, between the two rows of values and at the foot. All years, units, values and stub words were read at zoom 3.

[621] Arrangement of the page. The table stands at the head of the page across the full width of the text block, with no caption of its own; the stub head is blank. Column heads and stub labels are italic, the heads in two lines and the stubs in three, joined here. The last cell of each row prints a fraction as one small figure set over another with no rule between them, written here with a slash: in the fastest row 2 and 11/60 of a German mile; in the slowest row a numerator 1 over a lower figure that the print does not settle between two readings, carried with [?]. The table is ruled with vertical rules between the columns and horizontal rules at the top, under the heads, between the two rows and at the foot.

however much they are driven by a following and stronger wind, and than the flight of any merlin [Æſalonis] or hawk, and even than the motion of sound itself.

[Margin: Motus Cometarum velifico navium curſu, imò volatu avium & motu Soni eſt velocior.] *The motion of comets is faster than the sailing course of ships, indeed than the flight of birds and the motion of sound.*

[Margin: Quantâ celeritate aves ferantur, tum quanto temporis ſpatio ſonus exaudiatur.] *With what speed birds are carried, and in what space of time a sound is heard.*

For a ship scarcely covers three or four miles in the space of one hour. Likewise a bird (as we have been taught by plain example) flies through a single mile in one minute only with great difficulty; and as for sound, although it is much faster, we have nevertheless learned by experience that 18^{s} elapse before it can cross the space of one mile. All these, however, are trifling when compared with the cometary motion.

[Margin: An Autoris Theoria Solis motum Cometarum multò concitatiorem reddat?] *Whether the Author's theory of the Sun makes the motion of comets much more rapid?*

However that may be, you will nevertheless soon find that this motion of our comets is not so absurd, but rather quite in keeping with nature. First, then, you must know this. We have computed all the comets above with the mean distance of the Sun given as 5127 semidiameters of the Earth, according to our theory (which, God willing, we shall duly demonstrate and establish in our *Mechanica Coelestis* [Mechanicâ noſtrâ Cœleſti], soon to be published). The cometary motion is thereby made far more rapid than if we had used in the calculation Kepler's distance of the Sun from the Earth, 3381 semidiameters of the Earth, or Tycho's, which equals no more than 1200 semidiameters of the Earth. For on that assumption the comets turn out five times slower, and indeed to the extent that, instead of the 131 miles they cross in a single minute, they would then scarcely exceed 27 miles.

[Margin: Intervallum Solis à T[?]rrâ, juxta Ricciolũ & Wendelinũ.] *The distance of the Sun from the Earth [?], according to Riccioli and Wendelen.*

Nevertheless, even though the matter stands so, we cannot draw the Sun down closer to the Earth than it really is and than the observations plainly show (although others, namely Ricciolus [Giovanni Battista Riccioli] and Wendelinus [Govaert Wendelen], raise the Sun still far higher: the former to 7300, the latter to 14,656 semidiameters of the Earth, likewise at the mean distance). Therefore I certainly neither ought nor am able to do otherwise than examine and derive all these things according to our hypothesis.

[Margin: An talis velociſsimus motus Cometis ab Autore aſsignatus naturæ prorsùs adverſetur.] *Whether so very swift a motion, assigned to comets by the Author, is entirely contrary to nature.*

Let us therefore investigate whether the motion we have attributed to the comets is so unsuitable and wholly repugnant to nature, and then whether any

similar motion is found in the world. In my judgement, at least, as will also be shown more clearly very soon [mox mox], that motion according to our hypothesis is so far from being abortive and monstrous that, on the contrary, everything happens by that reasoning as congruently and in as due a proportion as it ever could; and by this motion our whole theory of comets is more and more firmly established.

[Margin: Quantâ velocitate Planetæ in ſuis Orbibus ferantur.] *With what speed the planets are carried in their orbs.*

So that it may at once be plain to all what kind of relation this motion of the comets has, whether a fitting or rather an absurd one, I think I shall do right if in advance [in antecesſum] I set before everyone's eyes the proper motion of all the primary planets in their orbs (that is, when they are carried in their swiftest course), and that likewise according to our said hypothesis, with the mean distance of the Sun from the Earth given as 5127. I now show this as well in the small table added here, with all the figures [of the working] left aside [remotis omnibus numeris]. From it will appear with what speed each of the planets, the superior as well as the inferior, is carried in any day, hour, minute and second, and how many German miles it covers.

Speed of the proper motion of the planets around the Sun, according to our hypothesis, with the distance of the Sun from the Earth given as 5127. [Velocitas motus Proprii Planetarum circa Solem, juxta noſtram hypotheſin dato intervallo Solis à Terrâ 5127.]

Planets [Planetæ.]	In one day, German miles [Vno die Mill.Germ.]	In one hour, German miles [Horâ prim. Mill.Germ.]	In one minute, German miles [Minuto primo. Mill.Germ]	In one second, German miles [Minuto ſecundo. Mill.Germ]
♄	25548	1064	18	1/3 nearly
♃	36466	1519	25	5/12
♂	64718	2696	45	3/4
♁	75832	3160	52	5/6 about
♀	94802	3950	66	1 1/10
☿	160204	6675	111	2 about

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[Margin: Luna minimè inter Primarios habetur Planetas.] *The Moon is by no means counted among the primary planets.*

[622] Arrangement of the page. This table stands in a ruled frame at the left of the text block below the first paragraph, with the following eleven lines of text set short beside it. Its caption is printed inside the frame over the columns. The column heads are italic and set over two or three lines, joined here; the planets are given by their signs, the fourth being the sign of the Earth. Each fraction in the last column is printed as one small figure over another with no rule between them, written here with a slash; 1 1/10 is a whole 1 followed by the fraction. The word rendered nearly is ferè and the word rendered about is Circ. A double rule stands under the caption and under the heads, and a single rule under the third row.

With such speed, then, are the primary planets, which acknowledge the Sun as their centre, now moved in their orbs. Of the Moon, by contrast, as a secondary planet which completes its courses around the Earth as the Jovials do around Jupiter, no account is taken here. For the Moon and the Jovials are only individual, or special, planets of some other primary wandering star, and their motion could not be compared with the motion of the comets as generally as that of the others. Saturn, then, covers 1/3 of one German mile in the space of one second, and Mercury almost 2 whole miles.

[Margin: Ex Theoriâ Tychonicâ & Ptolemaicâ motus Cometarum fit longe tardior.] *On the Tychonic and Ptolemaic theory the motion of the comets becomes much slower.*

But if I had shown the motion of these planets according to the Keplerian, or the Tychonic, or the Ptolemaic hypothesis, it would, I admit, be far slower, because those authors set the planets much lower. But it is all the same, and the matter comes to the same thing, whether you adopt our distance of the Sun or that of others.

[Margin: Proportio motus tam Cometarum quàm Planetarum ex omni hypotheſi eſt ſemper eadem.] *The proportion of the motion of the comets as well as of the planets is always the same on every hypothesis.*

For if you suppose any other, smaller distance, the motion does indeed come out slower, but in equal proportion the cometary motion then also becomes slacker, so that in this respect the distance of the Sun from the Earth contributes nothing at all to the matter. But so that you may see what difference there is between the motions of the planets derived from the different theories, I have gladly chosen to work them out from the hypothesis of Kepler and of Tycho as well, and to enter them in the table appended, although we do not attend to these on this occasion.

Speed of the proper motion of the planets according to the Keplerian hypothesis [Velocitas motus proprii Planetarum juxta hypotheſ. Keplerianam.] — Speed of the proper motion of the planets according to the Tychonic hypothesis [Velocitas motus proprii Planetarum juxta hypotheſ. Tychonicam.]

	In one day, in German miles [Vno die in Mill.Germ.]	In 1 hour, German miles [Hora I Mill.Germ.]	In 1 minute, miles [Minut. I Mill.]	In 1 second, miles [Secundo I Mill.]	In one day, in German miles [Vno die in Mill.Germ.]	In 1 hour, German miles [Hora I Mill.Germ.]	In 1 minute, miles [Minut. I. Mill.]	In 1 second, miles [Secund. I. Mill.]
♄	17254	719	12	1/5	5614	234	4	1/15
♃	24098	1004	17	1/4 about	8131	339	6	1/10
♂	40471	1686	28	1/2 nearly	13731	572	9	3/20
☉	50471	2103	35	7/12	17033	709	12	1/5

	In one day, in German miles [Vno die in Mill.Germ.]	In 1 hour, German miles [Hora I Mill.Germ.]	In 1 minute, miles [Minut. I Mill.]	In 1 second, miles [Secundo I Mill.]	In one day, in German miles [Vno die in Mill.Germ.]	In 1 hour, German miles [Hora I Mill.Germ.]	In 1 minute, miles [Minut. I. Mill.]	In 1 second, miles [Secund. I. Mill.]
♀	62635	2609	43	1/3 nearly	27653	1152	19	1/3
☿	105780	4407	73	1 13/60	70648	2944	49	5/6

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[Margin: Planetarum velocitas,juxta Tychonem & Keplerum.] *The speed of the planets according to Tycho and Kepler.*

When, therefore, we consider the slowest and the fastest motion of the comets, and compare it with the motion of the planets, namely Saturn, Jupiter, Mars, the Earth, Venus and Mercury [♄, ♃, ♂, ♁, ♀ & ☿], it becomes entirely clear, even though comets are only temporary planets, and

[Margin: Admiranda Harmonia & occultus conſenſus inter motum Planetarum & Cometarum pateſcit.] *A wonderful harmony and a hidden agreement between the motion of the planets and of the comets comes to light.*

bodies that perish, while the wandering stars are bodies eternal (in their own way) and coeval planets; and although the former move still [?] [adhoc] in a conical trajectory line, receding from the Sun or approaching it, toward this or that region of the sky, while the latter in turn continually perform their motion in a circle, or rather an ellipse, around the Sun, there is between the two motions, the cometary as well as the planetary, a great, hidden, indeed wholly admirable affinity and an incomprehensible harmony.

[Margin: Cœli enarrant Gloriam DEI.] *The heavens declare the glory of God.*

All of this should rightly spur us all on to raise our eyes and minds on high, to the infinite Wisdom and Power of God, Best and Greatest [DEI O. M.], and to his supremely admirable direction and preservation of all things, which we are to contemplate, weigh and look up to more and more, and to proclaim and celebrate his glory.

[Margin: Nullus Cometarum,quà motum proprium tardior ferè Saturno, atq; velocior Mercurio exiſtit.] *As regards proper motion, no comet is slower than Saturn, nearly, nor faster than Mercury.*

[623] Arrangement of the page. This table runs across the full width of the text block in one ruled frame, divided into two halves by a double vertical rule; the column of planet signs stands at the left of the first half only and serves both. The first four columns of figures are the Keplerian half, under the first caption; the last four are the Tychonic half, under the second. In the Keplerian half the fourth row is the Sun, given by its sign. The heads are set in three lines, joined here. Fractions are printed as one small figure over another with no rule between them, written here with a slash; 1 13/60 is a whole 1 followed by the fraction. The word rendered nearly is ferè and the word rendered about is Circ. A single rule stands under the third row in both halves.

For among those nine duly observed comets not a single one is found that was faster than Mercury or slower than Saturn. The slowest of all those comets covered 20 German miles in a single minute, and in a single second a third part of one mile, hardly any more slowly than Saturn itself advanced, which runs through 18 miles in one minute. Again, the comet that surpassed all the rest in speed covered 131 miles in the space of one minute, that is, 2 11/60 in a single second. Likewise Mercury, which is also the fastest of the other planets, advances 111 miles in the space of one minute and two miles in one second. I could wish that our predecessors had left us more such exact observations; the matter could without doubt be corroborated more firmly.

[Margin: Cometæ intra limites Syſtematis Planetarii continentur.] *The comets are contained within the limits of the planetary system.*

But from these nine, as many as are now available to us, we plainly find that all comets keep within the limits of the speed and the slowness of the planets, and scarcely ever go beyond the regions of the planets.

[Margin: Cometæ ſuo modo imitantur Planetas.] *The comets imitate the planets in their own way.*

Indeed, since comets are pseudo-planets, it seems to me very likely that they never fail to imitate the genuine and ordinary planets in their course. And I would believe this all the more readily because they arise from the evaporations and effluvia of the planets; hence they also take on and follow almost the same nature, and are subject to similar affections, though in their own way.

[Margin: Nullum eſt dubiũ, quin plurimaDEO dante, circa Cometarum negotiũ à Poſteritate detegentur.] *There is no doubt that, God granting, a great many things concerning the matter of comets will be discovered by posterity.*

In this matter, indeed, as I suspect, very many secrets still lie hidden. Although it is not yet granted to us to penetrate and uncover them, because the observations are scanty, I nevertheless hope that, with divine help, one admirable thing after another will at length be discovered in succession by tireless investigators of nature.

You could indeed object to us that the comet of 1607, when it had reached the lowest point of its course, namely on 1607 October 25, was a very little faster than the motion of Mercury. We reply that something so very slight is not to be heeded, especially since, as has been reported, this happened only on the last day of its appearance, a time at which it is easy to go astray in observations to that extent.

[Margin: Planetæ nondum ratione motûs ad ſummum veſtigiũ evecti ſunt.] *The planets, as regards their motion, have not yet been brought to the highest degree.*

I add this: suppose we move Mercury a little farther from the Sun and set it somewhat nearer the Earth than Kepler, whom I have followed here, wishes (which would certainly not be so very absurd either, since the motion of Mercury has not yet been brought to absolute perfection) — namely to 3000 semidiameters of the Earth, more or less [Sem. T.], although [ut ut] Riccioli

places it still farther from the Sun. Then Mercury would cover 130 [miles] in a single minute, and so 2 1/6 German miles in one second.

[Margin: Corpora, quò Soli propiora, eò veloeiora ſunt.] *The nearer bodies are to the Sun, the faster they are.* [recte: velociora]

And this would indeed be a stretch of travel entirely equal to the one that the comet of 1607 traversed at its greatest speed.

But even without this limitation our hypothesis, and the whole matter, stands on a firm footing [firmo talo]. For I agree with those who hold that the nearer any planet is to the Sun, the faster it moves and the shorter the time in which it completes the course of its orb. Then, too, since I have learned from observations that other comets sometimes pass nearer the Sun than Mercury itself, it is no wonder that the motion of certain comets is at times a little faster than the motion of Mercury. Not, indeed, only on account of the nearer distance to the Sun.

[Margin: Perpendiculum ex Sole ad Trajectoriam quò brevius, eò motus velocior eſt.] *The shorter the perpendicular from the Sun to the trajectory, the faster the motion.*

For, as we said above in its place, page 693, the speed of the cometary motion is not intensified or slackened solely according to this distance. Rather, the nearer to the Sun the comet's trajection takes place, the greater is the variation of the angle of inclination of the disc — that is, the angle of the Sun's ray with the trajectory, or the motion of the comet from the Sun; and then, the shorter the perpendicular to the Sun, the more rapid is the comet's course, if the constitution of its body is suitable enough for swift motion. So in all comets, where the trajectory is nearer the Sun, there the motion is more intense. After the example of all the planets, which, when they are nearer their centre, always proceed at a quicker pace and complete a greater stretch of travel in their orbit.

The comets imitate these in almost the same way: where their trajectory falls nearer the Sun, there they traverse a larger interval than when the trajectory, or the comets, are removed farther from the Sun.

[Margin: Tam Planetarum, quàm Cometarum remotiones à Sole retardant, viciniores verò accelerant motum.] *Removals from the Sun, of the planets as well as of the comets, slow the motion, while nearer [positions] accelerate it.*

From this it is certain that the planets and the comets are joined to one another by a certain hidden affinity: nearer the Sun, that is, they accelerate their motion, and farther away, in turn, they slow it. That is to say, so that you understand it rightly: the smaller the semidiameter of the planets' orb, the faster they are and the nearer they stand to the centre; and the more the trajectory of any comet is carried towards the Sun, the faster the comet moves, and it runs through less distance of travel, namely of that same trajectory.

[Margin: Quâ ratione iſta ſint accipienda.] *How these things are to be understood.*

For, so that you grasp the matter rightly, we are not speaking here of the difference of speed between different trajectories, set in different ways in relation

to the Sun, and so of a different motion among certain comets. What has been said about the different distances is to be understood only of one single comet in one trajectory. For other causes can be given, as has already been said, page 693, on account of which this comet's trajectory, although with respect to another trajectory it is nearer the Sun, may nevertheless be slower, and the reverse.

Therefore we have rightly shown that the motion of the comets, as regards speed and slowness in the trajectory, is very similar to the motion of the planets: in some cases hardly ever any faster than the motion of Mercury, and again hardly any slower than the motion of Saturn.

[Margin: Limites velocitatis & tarditatisCometarũ, quibus includantur.] *The limits of speed and slowness within which the comets are contained.*

But if we choose [not] to attend so strictly to the slowest motion of the comet of 1472, since none of all the others advanced with such slowness, nor to the last day of the comet of 1607, because of its speed, then we shall certainly not do badly to derive from this the limits of slowness and speed: that scarcely any comet passes through less than 40 semidiameters of the Earth each day, and moreover scarcely any passes through more than 200 semidiameters of the Earth: that is, [Margin: Quot milliaria uno ſcrupulo primo Cometa aliorum tardior & velocior conficiat.] *How many miles a comet slower and faster than the others covers in one first minute.*

[it] would pass in the space of one hour 1433 German miles, in the space of one first minute 24 German miles, and in the space of one second 2/5 of a mile — the one that would otherwise be the slowest; the fastest, on the other hand, would pass through 7170 miles, 120 miles and 2 miles.

[Margin: An abſurdum omninò ſit,adeò velociſſimum motum Cometis attribuere ?] *Whether it is altogether absurd to attribute so very swift a motion to the comets?*

For the rest, this motion, of the comets as well as of the planets, might seem to someone almost contrary to reason: namely, that they can swim through [tranare] 2 miles in the space of one second, that is, in three or four blinks of the eyes, or a single pulse of the veins. Yet there is no reason for you to wonder at this. For although you stand on the side of the Peripatetics, to whom those great distances of the celestial bodies according to the Copernicans are altogether distasteful, and who try, by means of those distances, to destroy the absurdity [abſurditatem … deſtruere] of the hypotheses of the Copernicans, we nevertheless can by no means draw the planets down nearer to the Earth, since we rely on indubitable observations and on the parallaxes of the Sun and the planets. But by what reasons you would prop up your opinion that those bodies are so much nearer to us — those reasons, I say, my mind longs to know.

[Margin: Comparatio inter motum Cometarũ & Primi mobilis in gratiam Peripateticorũ inita.] *A comparison between the motion of the comets and that of the primum mobile, made for the sake of the Peripatetics.*

The speed of motion, then, which results from our intervals of the celestial bodies is by no means unfitting and strange, but rather moderate enough

compared with [quà] the Peripatetics' diurnal motion of the ethereal bodies. Under the guidance of that motion (although no real spheres exist in the heaven, much less do they cling so firmly to one another; rather they float in the most fluid ether) these bodies are whirled round from rising to setting in the space of 24 hours, or rather carried round, in the view of the Peripatetic school, with the primum mobile as leader and guide, which they elsewhere raise far above the fixed stars.

[Margin: Quàm celeri gradu Planetæ nec non Fixæ motu diurno, juxta Peripateticorum,incedant.] *How fast the planets, and the fixed stars as well, advance in the diurnal motion according to the Peripatetics.*

But so that more weight may be added to our objection, and the motions of the planets and the comets may be compared with one another all the better, I have decided, once the calculation had been correctly made, to set before everyone's eyes in a special small table with what speed the primary planets — namely Saturn, Jupiter, Mars and the Sun — and also the sphere of the fixed stars are driven by the motion of the primum mobile, in the interval of one hour, of one first minute, of one second, and indeed of one third. And this according to our hypothesis, although I have hardly removed the orb of the fixed stars far enough from us with respect to Saturn, since I have supposed the gap between the fixed stars and Saturn only equal to the interval between Saturn and Jupiter — something which the proportion of the orbs otherwise allows only with great difficulty.

Planets [Plan-etæ.]	Hourly motion, German miles [Motus horarius. Mill.Germ.]	Motion of one minute, German miles [Motus unius Minuti. Mill.Germ.]	Of one second, miles [Vnius ſecundi Mill.]	Of one third, miles [Vnius tertii Mill.]
☉	1182500	19708	328	5
♂	3115027	51917	865	14
♃	7513927	125232	2087	35
♄	12856606	214277	3571	59
✶	20279752	337996	5633	94

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[Margin: His benè perpenſis, ſpero Peripateticos ſummam ſuæ opinionis inconvenientiam deprehenſuros.] *When these things have been well weighed, I hope the Peripatetics will perceive the utter unfitness of their opinion.*

You will therefore learn without any trouble, my Peripatetic, with what velocity and rapidity the wandering stars are carried round as regards the common motion; and then that I am by no means making the tortoise fly, however much [ut ut] I assert that in a single second the fastest comets and

[624] Arrangement of the page. This table has no caption; it stands in a ruled frame at the right of the text block, beside the eight short lines that open the following paragraph. The column heads are italic and set over two or three lines, joined here. The stub gives the Sun, Mars, Jupiter and Saturn by their signs and the fixed stars by an asterisk. A rule stands under the heads and under the Jupiter row, and at the foot.

planets, according to our more ample system, pass through two miles? I therefore have no doubt that you will at last come to your senses and return to a sounder mind. For if you believe, and grasp very well in your mind, that by the motion of the primum mobile the Sun can fly through 328 miles in the space of one second, Mars 865, Jupiter 2087, Saturn 3571 and the fixed stars 5633, you will surely grant us more readily that the comets and planets can at times, in so small a space of time, [Margin: Immane quantũ motus Communis Peripateticorum velocior eſt motu Cometarum,etiam alioquin velociſſimo.] *How enormously faster the common motion of the Peripatetics is than the motion of the comets, even though that is otherwise very swift.*

cover two miles. For 2 is exceedingly far from 5633; and it is far easier, with no one objecting, to cross 2 miles than 5600 and something over.

[Margin: Motu diurno, ampliùs ſpatiũ emetiuntur, quadrantis hor[[a/æ]] intervallo, quam eſt juxta nos inter Solem & Terram.] *In the diurnal motion they traverse more space in the interval of a quarter of an hour than there is, according to us, between the Sun and the Earth.*

On the contrary, I would rather say that it is foolish and utterly absurd to lay down firmly in one's own mind (notwithstanding, however, all those who dare to attack the annual motion of the Earth) that the sphere of the fixed stars can traverse, in the space of sixteen minutes — that is, in nearly a quarter of one hour — as great a stretch of the path of its circle as the interval we determine, according to our theory, between the Sun and the Earth. For you see clearly from the preceding small table that the motion of the primum mobile in one first minute is 337,996 German miles, and hence that the motion of 16 minutes is 4,507,930 miles. If the greatest distance of the Sun from the Earth according to our hypothesis, 5250 semidiameters of the Earth, that is, 4,515,000 miles, is set equal to this, we see that the stretch of ether is altogether equal.

[Margin: Copernicæorum Theoria longè profectò veriſimilior eſt, quàm Ptolemaicorum.] *The theory of the Copernicans is surely far more probable than that of the Ptolemaics.*

But tell me, pray, how it can be that you grant that with both hands, yet reject this, and so attack our theory — indeed, utterly abhor it — [saying that] we wish to force, as it were, monstrous and incomprehensible intervals of the orbs upon the world; when nevertheless anyone in possession of sound reason will without any doubt judge with us that the contrary is far truer.

[Margin: Theoriam Copernicæorũ funditùs ſtabilire, non eſt hujus loci.] *To establish the theory of the Copernicans from its foundations is not the business of this place.*

On this matter, believe me, much would remain to be brought forward, if it were my purpose to bring the ravings of the Peripatetics onto the stage and to dwell on them longer, or if my aim tended toward our wishing to establish our system, or the motion of the Earth [Telluris]. But since at present we intend something different, we put this off to another place and reserve it. Except that,

finally, we shall here meet a certain objection of the Peripatetics that might be raised.

[Margin: Ex contractiori ſyſtemate Ptolemaico nullum ſolamen obtinent Antagoniſtæ.] *From the more contracted Ptolemaic system the opponents obtain no comfort.*

For it could be inferred that we are striving to force upon them our most vast and by far most ample system, and that, this being supposed, so immense and so utterly absurd an hourly motion of the primum mobile results. But so that the opponents may be satisfied in this respect too: see, let us now set out the motion of the fixed stars by the primum mobile according to Ptolemy, the distance of the fixed stars from the Earth being taken, namely, as only 14,000 semidiameters of the Earth — although another, Wendelen for instance, places the Sun higher than we place Mars.

[Margin: Quantâ velocitate Fixæ motu communi ferantur juxta Peripateticos.] *With what speed the fixed stars are carried in the common motion according to the Peripatetics.*

From this it follows that, even according to the opinion of the Peripatetics, the sphere of the fixed stars moves 315,333 miles in the space of one hour, 52,555 in one minute, and 876 German miles in the space of one second; whereas, on the other hand, according to our theory comets and planets alike cover in their course only 2 miles in a single second. So it becomes plain again and again that our motion of the comets is far more fitting than the Peripatetics' motion of the primum mobile.

[Margin: Ex Ptolemaicâ Theoriâ, motus Cometarũ proprius multò tardior eſt.] *On the Ptolemaic theory the proper motion of the comets is much slower.*

For the rest, however, since our adversaries are pleased to have the dispute settled from the Ptolemaic hypothesis, we must also determine the fastest motion of the comets from that very theory. And then, surely, that motion of one minute will by no means grow to 120 or 130 miles — that is, to 2 miles in the space of one second — but will turn out far smaller. Namely, even if the comet were carried with its most rapid motion, it will nevertheless complete in the space of one hour 1794 miles, in one first minute 30 miles, and in a second only half a mile. Again, when it was slowest, it will pass through 294 in a single hour, 5 in a first minute, and in a second only one twelfth part of one German mile. Accordingly, once again

[Margin: Perinde eſt, qu[[à/â]] proportionẽ motus inter Planetas & Cometas, an laxiori, an verò ſtrictiori hypotheſi fruaris.] *As regards the proportion of motion between the planets and the comets, it makes no difference whether you use a looser or rather a stricter hypothesis.*

the matter comes back to the same point: namely, that the motion of the comets, even on this most confined Ptolemaic or Tychonic system, imitates the motion of the planets in every way, so that the slowest motion of a comet is hardly ever slower than that of Saturn, and the most rapid [hardly ever] faster than the motion of Mercury. For, as can be seen from the table on page 703 of

this Book, the speed of the planets according to Tycho, who places the Sun, roughly speaking [propemodùm], nearer to the Earth, almost coincides with the Ptolemaic: the former extends the slower motion of Saturn, in the space of one second, to 4 miles, and the latter to 5 miles; and so it shows the faster motion of Mercury at 49 miles, while the cometary motion is only 30 miles. But more than enough of this.

[Margin: Autori opus hocce ſub manibus crevit.] *This work grew under the author's hands.*

Now we shall pass on to the things that remain to be unravelled; but we shall dispatch them briefly, so that we may at last conclude this work. For we have been more long-winded than I had indeed imagined at the start.

[Margin: De motu Cometarum Libratorio.] *On the libratory motion of the comets.*

Since, therefore, enough has been said at length about the various motions of the comets, above all about the trajectory motion, there still remains another, which may rightly be called libratory. To begin with, it cannot fail to be known, without any doubt, to each and every observer of the heavenly bodies, both from our *Selenographia* and from the letter to Riccioli written and published in the year 1654, that the Moon does not always turn one and the same face toward us, however much this was indeed believed and asserted by our predecessors; but that at fixed times, now toward the east, now toward the west, indeed toward the south and the north, it successively presents to us a certain small part of the lunar body, and indeed of its hidden hemisphere, to such an extent that a motion of definite libration arises from it, as we have fully deduced and demonstrated in those same places.

[Margin: Prout in Lunâ, ſic etiam in Cometis certus motus oſcillatorius datur.] *As in the Moon, so also in the comets there is a definite oscillatory motion.*

In much the same way, all comets too, if we examine the matter more deeply, constantly perform a definite libratory or oscillatory motion. It is not to be denied, indeed, as we have proved in its place, that the disc of a comet is always bent toward the Sun; for that reason, while the comet continually advances, one variation after another arises in the angle of inclination of the disc.

[Margin: Cometa non ſemper unam eandem Terricolis exponit faciem.] *A comet does not always present one and the same face to the inhabitants of the Earth.*

But however much this may truly be so — namely, that the flattened faces of the comets are always turned toward the Sun — it by no means follows that the same part of the face is always exposed to us inhabitants of the Earth as well. Rather, for that very reason — since the same face is at all times turned toward the Sun, and the comet is carried ceaselessly along its trajectory, and moreover the Earth stands a considerable distance from the Sun and also moves in perpetual motion in the great orb, and hence forms various aspects with the Sun: the Earth, I say, is now in conjunction, quadrature, trine with the Sun, now in opposition — it cannot happen otherwise than that some parallax arises with respect to the disc of the comets.

[Margin: Quando Soli ac Terræ eadem facies corporis Cometici exhibeatur.]
When the same face of the cometary body is shown to the Sun and to the Earth.

For the Earth hardly ever falls into one and the same straight line with the Sun, so that the comet is seen from the Earth just as it is from the Sun; this, however, never happens to us except at the very opposition and conjunction. But even then this does not always happen, namely because of the obliquity of the ecliptic: for when the Earth is in Capricorn and Cancer, we see now more, now less of the comet's disc, and of its lower or upper part; unless the Earth is near the equinox — then, I say, at the conjunction and opposition of the comet roughly the same face of the disc appears to us. But since this very thing is infrequent, at that very time co-

Diagram. A full-page engraved plate with no text on the page, captioned *Fig. KK.* Twelve circles, lettered with capitals from M at the upper left down to A at the lower right, stand in a diagonal row; two labels written beside the row name it the trajectory of the comet. Each circle is crossed by chords whose ends carry small letters. A large curve, labelled *Orbis Magnus* (the great orb), runs round the left, top and right of the plate; the Sun stands at the left middle inside it, and four small hatched discs, each labelled *Terra* (Earth), stand on the curve, two of them also lettered P and T. Fans of straight lines run from the Sun and from the discs to the circles. The labels engraved on the plate:

The row of circles, from upper left to lower right:

- Circle *M*: *b* and *a* (upper right); *e* (lower right); *f* (upper left); *d* and *c* (lower left).
- Circle *L*: *a* and *b* (upper right); *e* (lower right); *f* (upper left); *c* and *d* (lower left).
- Circle *K*: *a* and *b*; *e*; *f*; *c* and *d*, placed as on L.
- Circle *I*: *a* and *b*; *e* (below the circle); *f*; *c* and *d*, placed as on L.
- Circle *H*: *a* and *b*; *e* (below the circle); *f* (upper left); *c* and *d*, placed as on L.
- Circle *G*: *a* and *b* (right); *c* and *d* (left).
- Circle *F*: *a* (right); *b* (lower right); *c* (above); *d* (left).
- Circle *E*: *a* (right); *b* (below); *c* (above); *d* (left).
- Circle *D*: *a* (right); *b* (below); *c* (above); *d* (left).
- Circle *C*: *a* (lower right); *b* (lower left); *c* (above); *d* (upper left).
- Circle *B*: *a* (below); *b* (lower left); *c* (above); *d* (upper left).
- Circle *A*: *a* (lower right); *b* (lower left); *c* (above); *d* (upper left).

Beside the row:

- *Trajectoria Cometæ.* (beside circles L, K and I): Trajectory of the comet.
- *Trajectoria Cometæ.* (beside circles D, C, B and A): Trajectory of the comet.

The great orb, the Sun and the Earth:

- *Terra.* (beside the disc at the top right of the curve): Earth.
- *Terra.* (beside the disc lower down the right side of the curve): Earth.

- *Terra.* (left of the disc at the left of the plate), with *P* below the disc: Earth, P.
- *Sol* (left of the sun-symbol): Sun.
- *Orbis* (along the lower left of the curve) and *Magnus.* (below its lowest part): the great orb.
- *Terra.* (left of the disc at the lower middle of the curve), with *T* below the disc: Earth, T.

At the foot of the plate:

- *Fig. KK.* (lower left): Figure KK.
- *Autor ſculpsit.* (lower right): Engraved by the author.

[Margin: Omnes & ſinguli Cometæ motui reciprocatorio ſunt obnoxii.] *All comets, each and every one, are subject to a reciprocating motion.*

mets can be observed; indeed, granting that it can sometimes happen, yet because of the motion of the comets and of the Earth that common line of sight would suddenly be changed. Therefore it is necessarily established that a reciprocating or libratory motion occurs in all comets with respect to us, or the Earth. And this is the reason why now somewhat more, now somewhat less of one side or the other of the cometary head or disc comes into view — now from the east, the west, now from the south and the north [Aquilone] — than if it were granted that the comet is always seen only from the Sun.

[Margin: Pr[[o/ò]] vario ſitu Cometæ ad Solem Terramq́; nunc major, nunc minor eſt motus Cometarum Libratorius.] *According to the varying position of the comet with respect to the Sun and the Earth, the libratory motion of the comets is now greater, now smaller.*

Accordingly, as the Earth, standing in the great orb, formed this or that aspect in relation to the Sun [quà Solem]; moreover, as it stayed in the more southern signs or in the more northern ones; no less, as the Earth moved to the right or to the left of the Sun, and the comet crossed this way or that in its trajectory — according to all these, I say, this libration or oscillation of the comet would be changed now a great deal, now a little, so that a little more of this or that part of the cometary body would be seen.

[Margin: Poſſe nonnunquam partem capitis omninò oppoſitam, ratione Solis, nobis in conſpectum venire.] *That the part of the head entirely opposite with respect to the Sun can sometimes come into our view.*

Indeed, it can sometimes happen, when the trajectory is parallel to the ecliptic and the comet is seen between the Sun and the Earth — namely at the very conjunction (which, however, hardly ever happens) or not far from it — that we then detect from the Earth the part of the head or disc entirely opposite with respect to the Sun; but only for a short time, according as the Earth then took up one place after another relative to the Sun and the comet.

[Margin: Motus reciprocatorius Cometarum Schemate declaratur & demonſtratur.] *The reciprocating motion of the comets is explained and demonstrated by a diagram.*

But let us set this out somewhat more clearly by a diagram and demonstrate that everything really is so, and that a libratory motion, although an entirely individual one in each single comet, does occur. For the sake of better understanding, let the head of the comet be round or spherical (however much it is otherwise in itself disc-shaped, or a body spread out flat), having a definite thickness. In the attached figure, then, let S be the Sun; the larger circle the great orb, carrying the Earth in its various places T, P, Q, O; and A, B, C, D, etc. the comet moved in its trajectory, namely from A to M. Next, let the hemisphere of the comet that is comprised by the angle *b* S *c* always be seen whole from the Sun; but from the Earth at T let that part of the comet be seen which is contained by the angle *a* T *d*; so that in this way we by no means see from the Earth the small part *c d* of the cometary body, which is indeed perceived from the Sun; on the other hand, we see from the Earth some small part *a b* to the east, in place of the other, *c d*.

[Margin: QuandoLibratio creſcat, rursùs decreſcat.] *When the libration grows, when it decreases again.*

From this we learn that, in such a trajection of the comet, namely, and such a situation of the Earth with respect to the Sun, the part *a b* of the cometary body (which is the genuine libration) grows and increases roughly up to D; but thereafter, with respect to the Earth T, it decreases again and diminishes up to M, where the libration almost vanishes, since the comet falls almost into the very conjunction with the Sun.

[Margin: Quando Libratio ex ortu ad occaſum migret.] *When the libration migrates from east to west.*

But if the libration is considered from the Earth at P, standing to the west, the appearance of this matter is entirely different. For, first, the libration is no longer seen toward the east but toward the west, and *c f* in place of *a b*, while *e b* vanishes entirely; this libration grows as the comet crosses from M to H, just as in the contrary course it decreases in turn, as the diagram shows. But if [the Earth] is at O or Q, and the trajectory runs on a parallel course with respect to the plane of the ecliptic, then it is granted to us to observe the comet at its conjunction with the Sun (which, however, hardly can happen), then, I say, the part entirely opposite as regards the Sun meets our eyes at F and G.

[Margin: Quando & quomodo ex Cometâ deliquium Sol patiatur,ſimul etiam Cometa eclipſetur.] *When and how the Sun suffers an eclipse from a comet, and at the same time the comet too is eclipsed.*

This tract of the cometary body, just as it cannot then be illuminated by the Sun in any way, so is it also noticed by us only with great difficulty — except that it may seem to bring some eclipse upon the Sun itself (if it stands in the same straight line with the Sun and the Earth).

[Margin: Rarò tamen Cometa totaliter deficit.] *Yet a comet is rarely eclipsed totally.*

But since the trajectory for the most part runs at a certain latitude above or below the plane of the ecliptic, or intersects that plane at a certain angle,

it follows that comets are lit by the Sun even at the very conjunction of the Sun and the Earth, so that we chance to see some small part distinctly at that time too. This small part, however, seems to vary from hour to hour, and so the cometary body itself now grows, now shrinks, according to the more upright or more oblique position of the trajectory with respect to the plane of the ecliptic.

[Margin: In Cometis omnin[[o/ò]] diverſa datur Libratio.] *In comets the libration that occurs is entirely diverse.*

From this it is now proven most evidently that, as was said above, a certain definite libration occurs in comets, but not one entirely alike and the same in all. And hence this libration can by no means be determined, because of the various and most diverse, indeed almost infinite, positions of the trajectory with respect to the Earth and the Sun. Meanwhile, however, the libration of each comet in particular could very well be investigated by calculation: namely, how great it was at this or that time, whether growing or rather shrinking; whether it was eastern or rather western? — and other things of this kind concerning it. But since this very thing can hardly be of any use, or contribute anything at all to this business of ours, I have deliberately excused myself from that labour.

[Margin: Quare certis regulis motum reciprocatorium comprehendere haud liceat.] *Why one may not comprehend the reciprocating motion by fixed rules.*

But to determine the libration of each and every comet under certain fixed laws and rules is, as I was just saying, a thing truly impossible. If indeed all of them, like the Moon, performed a certain and definite motion at all times, then this could certainly be done without any trouble. But each follows its own individual course and motion, at the most diverse inclinations of the trajectory to the plane of the ecliptic; and just as the progress of the individual comets can by no means at all be foreseen, so too it can in no way be investigated in advance.

[Margin: Vnde Cometæ plerun[[q́/q̄]]ue ex improviſo appareant ?] *Why comets for the most part appear unexpectedly?*

Lastly, from this libration we have uncovered, however special it may be, with other causes coming in besides, we are given a remarkable phenomenon that sometimes occurs in comets, and a deep question to be penetrated and demonstrated, which has until now given many people a great deal of trouble — so much, indeed, that they have despaired of it entirely: namely, why some comet comes into view as if suddenly and unexpectedly, at once from the very beginning of its appearance, when on the day or two before not even a trace of a comet appeared? Someone might perhaps say that the chief cause of this is the following: when we are still unaware of the rising of some comet, and are not yet concerned about or alerted to any comet staying in this or that place in the sky, it is hardly detected so easily by anyone (above all if it is of small size and shines with a dull light); moreover, several continuous cloudy days beforehand can shut off the sight of some new comet, so that it can be perceived by the eyes for the first time when the sky has at last cleared and become serene —

some days, that is, having passed since its true first appearance — with a body by then large enough and a bright light. But in my judgement all these do not yet account for that phenomenon. For, on the other side, suppose the sky is clear continuously for many days, and diligent observers of the stars have daily, and quite often, turned their fixed eyes toward it from every side, and have noticed that nothing at all new flashed out among the stars on the preceding day, but that on the following day, as soon as it came forth, it at once shone out beneath the northern stars of perpetual apparition with a notable and wonderful size; so that on one or two of the preceding days, in everyone's judgement, and from the proportion of the size of the cometary body well observed on the following days, it certainly could and should have appeared.

[Margin: Quando Cometæ breviſſimo temporis ſpatio conſpicuâ magnitudine nobis in oculos incurrant.] *When comets meet our eyes with a conspicuous size within a very short space of time.*

With these things granted, the question is: by what means can such a phenomenon come into our view unexpectedly? And what [things] are required for so sudden a rising of a comet, when on the day before not even a trace of any new phenomenon is noted, even by an observer otherwise endowed with rather keen sight, yet at once on the following day it shines with no ordinary bulk? First, it is certain and beyond doubt that a comet near the very conjunction of the Sun and the Earth, at F or G in the drawing above, will be imbued with hardly any light of the Sun — namely, if the trajectory runs not far from the plane of the ecliptic, and also on an almost parallel course, as was said above — and so also that this phenomenon can then come into our view only with difficulty, especially if it is at the same time removed by a very long interval from the Sun and the Earth. Moreover, if that freshly coagulated cometary matter were still very thin and subtle, and then, because of a less suitable condensation, incapable of illumination, at that time, I say, the comet would by no means appear. But when, in the following hours, the comet grows to a notable bulk through the encounter of some abundant matter, and also crosses toward the Sun and the Earth with a very swift motion — and indeed a retrograde one, against the order of the signs — so that a clear part of the cometary body is lit by the Sun's rays, it is beyond doubt, I say, that in such a case the comet can certainly burst forth suddenly, at once on the first day, with a very conspicuous size, though on the day before it was barely, even faintly, grasped by sight.

[Margin: De Macularũ Solarium ſubitaneis apparitionibus.] *On the sudden appearances of the solar spots.*

Sudden and abrupt appearances of this kind are likewise frequent in the solar spots, such as it has also fallen to me myself, not rarely, to notice. For on 1643 August 16 (as is evident from course IX of the spots, p. 508 of our *Heliographia*), I distinctly noted various bright and evident spots on the Sun's disc, although on the day immediately before nothing but shadows and very faint and very

small secondary spots were visible, while on the second day back from this, namely August 14, almost nothing at all came into view.

[Margin: Admodùm notabilis Macula anno 1644 ab Autore deprehenſa.] *A very notable spot detected by the author in the year 1644.*

A similar phenomenon was observed on 1644 May 10, concerning that remarkable and very large spot *d* (p. 519 of the said *Heliographia*). In the space of two days this spot had grown so much, and had so changed itself, beyond what even I myself would ever have believed or hoped, had it not been granted me to perceive that very thing with my own eyes.

[Margin: Poſſe Cometas nonnunquam ſubitò exoriri, exemplis m[[a/á]]cularum comprobatur.] *That comets can sometimes arise suddenly is proven by the examples of the spots.*

Therefore, since the solar spots can undergo such wonderful changes and vicissitudes, and take on increases, in so very few days, indeed in hours, right reason certainly persuades [us] that the same can equally befall comets, whose generation, augmentation and accretion come about in almost the same way.

[Margin: Cur Cometæ quàm Maculæ citiùs grandeſcant, ut conſpici queant.] *Why comets grow large more quickly than spots, so that they can be seen.*

Above all, because in comets other causes are added besides, of which the spots are entirely free: for example, that some comet approaches the Earth more and more in a continuous course, and at the same time is driven with a contrary motion in relation to the path of the Earth; moreover that it successively quickens its pace closer to the Sun and the Earth. All these causes can indeed come together in one and the same comet, but in the spots in no way. For the solar spots almost always keep the same distance from the Earth and the Sun; then, their proper motion is of hardly any importance, indeed almost none, and the annual [motion] of the Earth contributes nothing at all to this matter; so that every variation and augmentation redounds solely to the matter of the spots. According as that matter flows in more copiously and coagulates more quickly, a spot can sometimes be increased very quickly and at once become very large, which a little before was quite small, indeed entirely eluded sight. Whereas in comets, on the other hand, very many causes concur that accelerate the apparent and the true size of the body, so that it is easy for us to see a comet large in bulk, unforeseen and unexpected, right at its first rising.

[Margin: Quamdiu Cometa in ſuâ Trajectoriâ perſeverare poſſit.] *How long a comet can persist in its trajectory.*

Finally, to hasten to the end in this dissertation of ours on comets, the question is: how long can a comet stay in its trajectory? That, as far as I judge, it is by no means possible to determine from physical reasons, since the matter itself is not yet well enough known to us, nor have all the accidental causes been properly explored. But as far as is clear to us from history, and as examples show, one has been far longer-lasting than another; those that, of them all, reached a more advanced age (except the one that hung over [imminuit] the people of Jerusalem) appeared for six or eight months.

[Margin: Alii Cometæ per octo Menſes fuerunt conſpecti.] *Other comets were seen for eight months.*

For example: 1. In the reign of Nero, in the year 60 after the birth of Christ, a comet was seen in the sky for six months. 2. In the year 375 another, for eight months. 3. In the year of Christ 1240 [one] lasted beyond six months; but the one that hung above Jerusalem consumed a whole year in its duration. Much, indeed, would have to be inferred about this comet, if the consideration of time did not advise against it; above all it would have to be inquired whether this was a genuine comet? or rather a singular, wonderful and extraordinary portent of GOD?

[Margin: De Cometâ Hieroſolymitano, an fuerit ſingulare DEI oſtentum, an verò genuinus Cometa.] *On the comet of Jerusalem: whether it was a singular portent of God, or rather a genuine comet.*

Since no similar example of any comet is found in the whole history of the world that was visible only in a certain place, as this haired star indeed was at Jerusalem. But whatever it may be, this time nonetheless I embrace that comet as genuine (although in truth I think otherwise), with this in view: that it will contribute much to unravelling the following questions, and will also lead us to higher things.

[Margin: An Cometa ejusmodi longævus tanto tempore non excedat ſyſtema Planetarium, imò totam Mundi Machinam, attento, quòd adeò velociſſimo feratur curſu ?] *Whether a comet so long-lived does not, in so long a time, go beyond the planetary system, indeed the whole machine of the world, considering that it is carried on so very swift a course?*

Comets are therefore, as was said and proven by examples, fairly long-lived, since they sometimes last 4, 6 and 8 months and more. Hence it is rightly asked whether it is also entirely consonant with reason that a comet can subsist in its trajectory for so long an interval of time? Moreover, whether in this way the trajectory would grow out beyond the sphere of the fixed stars, indeed almost into infinity? — namely, if the comet is moved with such great velocity each day along the course of its path (as we showed above), and continually for so long an interval of time? The investigation of this question is not only pleasant, but seems to have its own usefulness. For by means of it either the absurdity of our hypothesis, or its elegance and truth, will become clearly known.

At the outset, if all these things are to be explored thoroughly and this dispute settled completely, it is necessary to recall to memory once more with what velocity comets are carried in the trajectory? Now the slower ones cross 30 in one day, but the faster ones 220 semidiameters of the Earth. If we take the middle, a comet will run through 120 or 130 semidiameters of the Earth each day, according to our hypothesis. But in order to indulge this matter more than enough, and to do it no violence at all, let it be supposed that a comet completes 150 semidiameters of the Earth daily, and that with a continuous motion from the beginning to the end of its apparition, although no example of that velocity exists. The question is, then, whether a comet, in the space of

4, 6 or 8 months (not to say a whole year), flies through the whole system of the world, which embraces the orbs of all the planets and of the fixed stars, and so goes clean out of it?

[Margin: Evidens argumentum,The[[o/ó]]riam noſtram non usq̃; adeò esſe abſurdam] *A clear argument that our theory is not so very absurd*

If the thing could properly be affirmed, I gladly admit that our theory totters, and deserves to be removed and rejected because of the evident inconveniences and enormous absurdities that arise from it. But if, on the contrary, it is shown that no comet, neither in the time stated nor when a whole year has elapsed (granting that a comet passes 150, indeed even 220 semidiameters of the Earth in one day, which hardly a single one of them all has travelled with its swiftest motion, so that the matter may come out all the clearer), can pass through even the planetary system: will you not, my Peripatetic, freely concede the contest [herbã ultrò dabis], and come over to our side? For however hard you try, you will by no means at all achieve it by your hypothesis, as will shortly be shown at greater length.

And so let us explore how much space a comet measures out in its trajectory each month, given its daily motion of 150 semidiameters of the Earth; and let us enter the numbers in the attached little table, and at the same time also the distances of all the planets according to our hypothesis, at their greatest remoteness from the Earth, with the radii and diameters of the orbs added as well.

[Margin: Quantitas & proportio Orbium Planetarũ; tum quantum Cæli ſpatium Cometa transeat ſingulis menſibus.] *The size and proportion of the orbs of the planets; and how much space of the heavens a comet passes each month.*

Duration of comets in months	How much space of the heavens a comet runs through, in semidiameters of the Earth	Plan-ets	Semidiameters of the planets' orbs, in semidiameters of the Earth	Total diameter of the planets' orbs, in semidiameters of the Earth
1	4500	☿	5157	10314
2	9000	♀	5157	10314
3	13500	♁	5250	10500
4	18000	♂	13830	27660
5	22000	♃	33360	66720
6	27000	♄	57080	114160
7	31000	Of the fixed stars	60000000	120000000
8	36000			
9	40500			
10	45000			
11	49500			
12	54000			

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From this it is clearly established both how great an interval a comet crosses in any month, and of what vastness the sphere of each planet is. And from this the matter can now easily be thrashed out: whether a comet could, in some months, that is, or in a whole year, go beyond the whole system of the world by its motion (granting it, as we said, a daily motion of 150 semidiameters of the Earth)? But indeed, wise reader, you will rather perceive that, even if such a very swift motion were granted for, say, the whole duration, the comet can nevertheless hardly travel through the whole orb of Mars in the space of six months, that is, in a straight line drawn through the centre; indeed, in twelve months it cannot measure out even the whole orb of Jupiter, much less that of Saturn.

[Margin: Sex menſium ſpatio,Cometa, ut ut velociſſimus,vix tamen totum Martis Orbem trajicit.] *In the space of six months a comet, however swift, still hardly crosses the whole orb of Mars.*

For to pass through the space of this heaven, two years and 31 days are required.

[Margin: Quanto temporis intervallo Com[[e/é]]ta opus habeat, quò Saturni regionem pervolet.] *What interval of time a comet needs to fly through the region of Saturn.*

Indeed, even if we grant the swiftest daily motion of all that has ever been detected in any comet, that is, 220 semidiameters of the Earth, it will nonetheless spend in all a year, five months and some days on its course before it crosses this orb of Saturn along its diameter.

What more is to be answered to this, I certainly do not see. Do not all things hold together in order, neatly and fittingly, on this hypothesis of ours? Indeed, most of all.

[Margin: Ex noſtrâ hypotheſi nunquā Cometa ſyſtema Planetarium egreditur.] *On our hypothesis a comet never goes out of the planetary system.*

[Margin: Amplitudo Sphæræ Fixarum.] *The size of the sphere of the fixed stars.*

For so far is any comet from going beyond the diameter of the sphere of the fixed stars, or of the whole system of the world (which is put at 120,000,000 semidiameters of the Earth from the proportion of the other planets), that it never even goes out of the planetary system, but always keeps itself within its limits and completes its course.

[Margin: Quantum temporis interſtitium requiratur, donec Cometa à Sole ad Saturnum perveniat.] *How great an interval of time is required until a comet reaches Saturn from the Sun.*

[625] On the page the table stands in a ruled frame at the right of the text block, with the paragraph beginning From this it is clearly established set in a narrow column beside it. The italic words for the fixed stars are set over the rows for months 7 and 8. Rules divide the rows into groups of three; the cells left empty here are blank on the page.

Yet someone could object by asking: if a comet were generated in the atmosphere of the Sun (as can happen rather often, in our view too) and began its motion there first, how much space of time would the comet spend before it reached Saturn from there? Although this question seems at first sight very weighty, it will nonetheless by no means confound our theory, much less destroy it completely.

[Margin: Quantum intervallum integro anno Cometa aliàs velox curſu emetiatur.] *How great an interval a comet, swift as it otherwise is, measures out on its course in a whole year.*

For I grant that a comet travels 150 semidiameters of the Earth each day by its motion. Will it then be able to measure out the radius of the orb of Saturn on its course in an interval of six months? By no means; indeed, not even in the space of twelve months. For in a whole year it runs through only 54000 semidiameters of the Earth, whereas the semidiameter of the sphere of Saturn is 57000 semidiameters of the Earth, so that 3000 semidiameters of the Earth still remain.

[Margin: An ſuppoſito ſyſtemate ſtrictiori Ptolemaco, res non alier cadant.] *Whether, if the narrower Ptolemaic system is supposed, things do not fall out otherwise.*

But perhaps you will infer that I allow myself too much licence in embracing so very vast a system and setting the stars back at such great intervals. But by this objection you will neither obtain nor extort anything, much less carry off the victory. Even if we assume the Ptolemaic or Tychonic proportions of the orbs, you will nonetheless fall back into the same darkness and the same snares. For since these orbs are four times smaller than ours, the motion of comets too must become slower in that same proportion, as we showed a little earlier on p. 707, so that the daily motion of a comet is then only 50 semidiameters of the Earth, even if on our system it comes out at 150 semidiameters of the Earth.

[Margin: Quantum intervallum Cometa trajiciat ſingulis menſibus; tum quantæ magnitudinis ſint Orbes Planetarum ſecundùm Tychonem.] *How great an interval a comet crosses each month; and how great the orbs of the planets are according to Tycho.*

If, then, the calculation is made correctly and compared with the diameters of the planets' orbs, you will see that you are stuck on the very same rocks again, so that comets can reach the bounds of Saturn not even in the course of one year, but only in 16½ months. This can be seen from the attached little table, in which you will have both how much space a comet measures out in one or two months, and the sizes of the orbs according to Tycho.

Duration of comets in months	How much space of the heavens a comet runs through according to Tycho, in semidiameters of the Earth	Planets	Semidiameter of the planets' orb according to Tycho, in semidiameters of the Earth	Total diameter of the planets' orbs according to Tycho, in semidiameters of the Earth
1	1500	☿	1150	2300
2	3000	♀	1150	2300

Duration of comets in months	How much space of the heavens a comet runs through according to Tycho, in semidiameters of the Earth	Planets	Semidiameter of the planets' orb according to Tycho, in semidiameters of the Earth	Total diameter of the planets' orbs according to Tycho, in semidiameters of the Earth
3	4500	☉	1190	2380
4	6000	♂	1745	3490
5	7500	♃	7405	14810
6	9000	♄	12300	24600
7	10500	*	14000	28000
8	12000			
9	13500			
10	15000			
11	16500			
12	18000			

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[Margin: Autor putat, ſe Antagoniſtis planè ſatisfeciſſe.] *The author thinks he has fully satisfied his opponents.*

I therefore have no doubt that in this part too I have satisfied our opponents by the full bushel [pleno modio]. On the other side, however, I very much doubt, truly, whether they themselves, by means of the Aristotelian hypothesis, which supposes all comets in the aerial region, have paid what they owe either to us or to themselves, as will shortly have to be shown; provided that I first set out here how great an interval of the aether any one of those nine comets, in its trajectory, [an interval] derived from the observations themselves, actually crossed? Or how long the conic section of each comet was, which it completed by its course over the whole time of its duration; and then what proportion holds between the said sections of the trajectories and the orbs of the planets?

[Margin: Quot Semid. T.nonnulli Cometæ, totá ſuâ duratione peragrav[[e/è]]rint; ſive quantæ fuerit longitudinis eorum Trajectoria.] *How many semidiameters of the Earth some comets travelled through in their whole duration; or how great the length of their trajectory was.*

This, however, is readily done, since the daily proper motion of each comet through its whole apparition has already been given above, on p. 688, in a little table. If this is brought into a sum, it will at once be clear how long a journey each comet measured out, and how great the conic section of its travelled path was, as the attached little table shows.

[626] On the page the table stands in a ruled frame at the right of the text block, beside the paragraph beginning I therefore have no doubt, which is set in a narrow column at its left. The third planet row carries the sign of the Sun, where the table on the preceding page has the sign of the Earth; the seventh row carries an asterisk, standing for the fixed stars. The head of the first column is printed Dnratio. Rules divide the rows into groups of three; the cells left empty here are blank on the page.

Comet	1472	2950	semidiameters of the Earth
	1531	1097	
	1532	2370	
	1577	5836	
	1585	4328	
	1590	1843	
	1607	3165	
	1618	7209	
	1652	2031	

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[Margin: Nullus omnium ritè obſervatorum Cometarum, vel tantùm diametrũ Orbis magni emenſus eſt.] *None of all the duly observed comets has measured out even so much as the diameter of the great orb.*

It is therefore clear that none of these comets extended its course so far as to equal even the great orb alone, according to our hypothesis. For although the comet of the year 1618 completed the greatest journey of all the others, it nevertheless did not go beyond 7209 semidiameters of the Earth. Others, indeed, which lasted for the space of 4, 6 and 8 months, without doubt travelled somewhat farther; nevertheless, as I am thoroughly convinced, they by no means went beyond the whole sphere of Saturn, indeed not even half of it, even if they had lasted a whole year and completed 150 semidiameters of the Earth daily.

[Margin: Cometæ omn[[e/é]]s intra limites ſyſtematis Planetarii, ſemper permanent.] *All comets always remain within the limits of the planetary system.*

From this we prove again and again that we have abundantly fulfilled our promise: namely that comets, just as they are first born in the planetary system, so also never go out of it, as we were saying at length just now.

[Margin: Inquiritur ex hypotheſi Peripatetic[[â/d]], datis Cometis ſub cõcavo Lunæ, an aliquis eorum aliquot menſiũ ſpatio in aëre ſublunari ſubſiſtere poſſit ?] *It is asked, on the Peripatetic hypothesis, granting comets beneath the concave of the Moon, whether any of them could subsist in the sublunary air for the space of some months.*

But let us see, kind reader, what the Peripatetic school will achieve by its hypothesis: whether it will accomplish the whole matter with equal neatness and fitting harmony, or proportion, so that we too may be able to grasp in our minds the agreement of that theory. We have indeed shown, in a long series, from parallaxes correctly and duly derived from observations, that comets move in the highest aether; yet let us grant for this once that a comet travels beneath

[627] On the page the table stands in a ruled frame at the left of the text block, with the paragraph beginning It is therefore clear set in a narrower column beside it. The word for comet stands in the first column of the first row only, and the unit in the last column of the first row only; the other cells of those two columns are blank on the page. Rules divide the rows into groups of three.

the concave of the Moon. The question, then, is whether it could stay there for six, eight or twelve months, and at the same time complete its whole journey in the manner stated. For this purpose let us take the daily motion of the comet as only 50 semidiameters of the Earth, from the hypothesis not of ours but of Tycho and Ptolemy; a slower one we do not concede, since we have already fully established this in its place by an infallible calculation of parallaxes.

[Margin: Si in aëre Cometa daretur, vix per unum diem conſpiceretur.] *If a comet were granted to be in the air, it would scarcely be seen for one day.*

And so it follows that, if, that is, a comet were generated from terrestrial vapours, it could not stay even a single day beneath the concave of the Moon, which is removed from the Earth by only 54 semidiameters of the Earth, to say nothing of a whole month, or more; much less a whole year. Whether this very thing agrees with the truth, and answers in every way to all the observations, let you and other fairer judges of these matters decide.

[Margin: Si [[à/á]] Peripateticis detur, Cometas poſſeper menſes aliquot commorari; vix,ſan[[è/é]], pedes aliquot ſingulis diebus tranſiret.] *If the Peripatetics grant that comets can linger for some months, [a comet] would, truly, scarcely cross a few feet each day.*

Moreover, what astonishing absurdities and inconveniences, I ask, would arise if we supposed that comets are generated and move in our vaporous orb! For [a comet] would be seen above the horizon for scarcely the space of one hour, or another, as we have shown more than enough in Book III, p. 151. But suppose it is visible to us for six months: the further question is how much space of its journey it would complete in its orbit in one day? Scarcely six perches, I say, o- r 60 or 70 Roman feet. Yet it must be moved with such great speed (as everyone will readily acknowledge) that it can be seen to reach from one fixed star to another, and indeed so swiftly, as sometimes happens: which can by no means happen given, that is, a daily motion of a few perches, or feet. But enough, and more than enough, about these things, since this opinion is so absurd that it has no need of a fuller refutation.

[Margin: Cur Cometæ pleruńq; ad Septentrionem feruntur ?] *Why comets mostly travel towards the north.*

Finally, to put an end to this Book on the motions of comets, we shall settle just one question, by way of a supplement: namely, why do more of the comets mostly travel towards the north, and fewer towards the south, west or east? As was observed in the comets of the years 411 and 27 before Christ; likewise in the years 1165, 1211, 1240, 1304, 1313, 1314, 1351, 1362, 1394, 1400, 1472, 1533, 1556, 1618, 1652, and others.

[Margin: Philoſophi hâc de quæſtione valde fuerunt hactenus anxii.] *Philosophers have until now been very anxious over this question.*

This question has so tormented many that they have until now almost despaired of solving it, as Libertus Fromondus [Libert Froidmont] in particular attests in Book III of his *Meteorolog.* For he says in Article IV, p. 212: *But what is the cause of this proper motion? The matter is again hidden and clouded.* Likewise

on p. 215: *But why do more of the comets strive and go towards the north by their proper motion? Here I am stuck. Nor do I know how I might get out of it, unless it is this: the sweeping of the aether by the planets that cut through it, or, if you prefer, by the prime mover from east to west, is more rapid about the equinoctial and the middle of the heaven than about the poles of the world. Hence a comet born, for example, in the aether of the torrid zone, and striving to cross it upwards, is gradually drawn aside to where the sweeping is gentler and the aether as it were stagnant; and so, its lightness as it were seeking a softer passage, the comet is moved off towards the southern or the northern pole of the world, out of the torrent of the most rapid aether. Unless, however, you prefer here once again to weep and to implore the help of the angels.*

[Margin: Quid cauſæ ſit, ex Autoris ſententiâ, quòd Trajectio Cometarum ad Aquilonem vergat.] *What, in the author's opinion, is the cause of the trajectory of comets inclining towards the north.*

These words are clear proof, to say nothing of others, of how much effort and how much anxiety they have spent on the matter, and how they have taken pains to uncover its causes, but in vain. Let us therefore try whether we can aim somewhat closer to the mark, and indeed on the supposition of our hypothesis. You have understood without doubt, my reader, if you have weighed with a somewhat more attentive mind what we said in Book VII, p. 426: namely, that comets are produced more quickly at the time of the great conjunctions.

[Margin: In conjunctionibus faciliùs citiuſq; Cometæ naſcuntur.] *In conjunctions comets are born more easily and more quickly.*

And this chiefly for these reasons: that when most of the planets stay not far from one another, either in the conjunction itself or in one angle of the heaven, all those evaporations and exhalations rising from so many atmospheres run together, combine and coalesce more readily than if the planets were dispersed here and there through the whole zodiac, separated from one another by such great intervals and breathing out their effluvia in different parts of the heaven; as can be understood more fully in that place.

[Margin: Atmoſphæræ Cæleſtes ſub quâ elevatione Poli circumrotentur, quà Polos Mundi.] *At what elevation of the pole the celestial atmospheres revolve, with respect to the poles of the world.*

With this above all borne in mind (which I think it worth while to add here): that the poles of the atmospheres of all the planets are strongly inclined to the equator and the ecliptic, so that the equinoctial of the atmospheres extends almost upwards or downwards (if one may speak so), towards the poles of the world, that is, towards the north or the south. And hence the whirling motion [motus vertiginis] of the said spheres is carried by a fixed law towards the north and the south. Granting this, it certainly follows that those effluvia, issuing from the vaporous orbs of the conjoined ethereal bodies, more readily and more quickly either in the south or in the north, are joined and gathered together.

[Margin: Si axes Atmoſphærarum eſſent paralleli axi Mundano, vix facile unquam Comet[[a/æ]] generaretur.] *If the axes of the atmospheres were parallel to the axis of the world, hardly ever would a comet easily be generated.*

For if all the axes of the atmospheres were entirely parallel to the axis of the world, evaporations would be expelled from absolutely any vaporous orb, namely along a course parallel to the equator; but these would surely never be gathered together, their motion, namely, being entirely parallel, so that the generation of some hairy star would occur more often in the conjunctions of the planets. But since the appearance of comets happens more often about conjunctions, as observations confirm, the poles of the atmospheres of the ethereal bodies certainly lie for the most part over the ecliptic and the equinoctial of the world, though at some elevation (as I would readily grant, for certain reasons to be raised elsewhere); and with respect to our oblique sphere those atmospheres are always more upright, and their whirling motion, or circumgyration, is also carried towards the poles.

It therefore follows absolutely, especially if the effluvia come forth about the equator, under the great circles of their atmosphere, that comets are for the most part carried across either towards the south or towards the north.

[Margin: CurCometæ non adeò frequenter ad Auſtrum, quam ad Septentrionē vergunt ?] *Why comets do not tend towards the south as frequently as towards the north.*

But that not as many comets are seen in the southern region as in the northern comes about from this: even if they are perhaps ejected there just as often, and the evaporations coagulate into a new cometary body, yet before that body, setting up its motion below the ecliptic more and more towards the south, strikes our eyes and grows to so great a mass that it can be seen, it completes some tens of degrees in its southern path before it comes forth; and then it mostly lies hidden already below our horizon and proceeds towards the south pole, where, unless it is very conspicuous in body and brightness, it is very rarely recognized and observed. So very many go into hiding there, namely when the cometary matter bursts out about the northern parts of the atmosphere.

[Margin: In parte Mundi Auſtraliori, plurimiCometæ pereunt, & minimè obſervantur.] *In the more southern part of the world very many comets perish and are observed least.*

On the contrary, however, when the impulse is given towards the north [Aquilo], and the cometary matter inclines that way, the farther it runs out towards the Arctic pole, the riper it becomes; it grows more and more, and then is seen more perfectly and for longer, so that hardly any one perishes that is not well noted somewhere by some practised observer of the heaven and the stars. I conclude, therefore, that very many comets are necessarily carried towards the north and complete their journeys there.

Johannes Hevelius, Cometography, Book Ten [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER DECIMUS.]

Presenting the Description, and the Genuine Observations Themselves, and also the Theory of the Comet of 1661 [Deſcriptionem, atq3 ipſas genuinas Obſervationes, nec non Theoriam Cometæ 1661 exhibens.]

[Margin: Autor initiò decreverat peculiarem librum de effectibus & ſignificationibus Cometarum conſcribere.] *At first the author had decided to write a separate book on the effects and significations of comets.*

I had fully resolved, once the preceding Book on the motion of comets had been brought to its end, to append here just one single book on their effects and significations, and so, with the history of all comets, to put an end to this work altogether.

[Margin: Quare mentem mutaverit.] *Why he changed his mind.*

But having well recognized that very many authors, of the more recent as well as of the more ancient, had treated that astrological matter concerning comets fully enough and properly, and moreover that I am by no means so earnest a cultivator and follower of these studies, I abandoned the plan entirely.

[Margin: Autor nec admodùm adhæret Aſtrologiæ, nec eam omninò rejicit.] *The author neither adheres much to astrology nor rejects it altogether.*

I do not indeed altogether despise and reject astrology as a whole; but nevertheless I do not attribute to it as much as very many people usually do, nor do I rely so firmly on its foundations. For the reasons by which astrologers try to establish their case do not satisfy me and remove every doubt. Above all, since all astrology rests chiefly on the moment of birth, and holds this as its foundation, on which it, as it were, plants its foot.

[Margin: Quo tempore, Cometarum contingat nativitas.] *At what time the birth of comets occurs.*

But this is by no means ascertained from the time when a comet first comes into view to this or that person; rather, according to our hypothesis, set out in this work, that point of birth would become known from the very beginning of the comet's generation, that is, when the exhalations and evaporations from the ethereal bodies first began to join together, and some new cometary body took its very true beginnings.

[Margin: Nullius Cometæ verum tempus nativitatis recte compertum habemus.] *We have not rightly ascertained the true time of birth of any comet.*

But since it has so far been granted to no one on earth to investigate and discover this, we therefore in no way know that true time of birth; and consequently no one is at liberty to erect any astrological figure [thema] duly and properly, much less to predict from it anything solid or true, even if we wish to keep those universal principles of the art of divination in their force; which, however, seem to me, as also to a great many others, not so very consonant with reason.

[Margin: Cometarum adſpectus, ſuas quoque habent operationes.] *The aspects of comets also have their own operations.*

I do not indeed absolutely deny that various aspects, as between the planets and the fixed stars, so also in an almost similar way between comets and the planets and the stars, n- ot at all produce and exert effects and operations; but it is plainly in [my] mind [?]: since the more ancient [writers] were formerly very little concerned with the motions of comets (so that hardly ever, up to the times of Regiomontanus and Apian, had they measured any hairy star [Sidus Crinitum] correctly and exactly), and attended no more duly and scrupulously to the effects of the various aspects, namely what kind of outcome had followed after this or that malevolent or benevolent position, so that from this nothing at all certain can be derived and foreseen from all of them.

[Margin: Sed quales ignoratur.] *But of what kind [they are] is not known.*

Yet I hold it not absurd, if you indulge the astrologers, that malevolent as well as benevolent aspects of the ethereal bodies can occur; it must certainly also be granted that the various aspects of comets and stars, which change from day to day, produce very diverse effects and operations. For comets, because according to our hypothesis they take their origin from the planets, at the same time claim for themselves a part of their nature.

[Margin: Cometarum alii ſunt maligni, alii benigni.] *Of comets, some are malign, others benign.*

Therefore it necessarily follows that not all comets are malign and signs of evil outcomes, as very many think, but some are benign, and more often forerunners of the most fortunate actions; as it is open to confirm and demonstrate from very many histories and examples.

[Margin: Aſtrologicæ de Cometis Autor aliis committit.] *The author entrusts astrological matters concerning comets to others.*

But since we have resolved to raise nothing further at all on this matter, let us leave it to the sons of the astrologers, namely to those more eager for these things, or freer from business and cares. I rest content that I have set out and investigated, according to my slender measure, the astronomical and physical matters bearing on the whole business of comets; and since, beyond all hope and my purpose, this labour has turned out much larger and more toilsome, I wished all the more to give attention to brevity, and all the sooner to put the last hand to this work.

Nothing more would therefore remain than for me to add the history of comets and at last reach the goal of the whole work.

[Margin: Autor explorandum duxit, an etiam recentiorum CometarumPhæ nomena Theoriæſuprà tra. ditæ conveni. ant.] *The author thought it should be explored whether the phenomena of the more recent comets also agree with the theory set out above.*

But since in recent years, while the Cometography was still in ferment under my hands and I was dwelling above all on the motion of comets, GOD, Best and Greatest, brought three very different comets into our view, which I myself

also examined successfully (in my judgement), with the divine power favouring, with instruments not altogether unsuitable, I considered it very much worth the effort to examine all of these too as diligently as possible, to weigh them and to investigate them by calculation: whether, and how far, they also agreed with our hypothesis, set out at length in the preceding Book; whether likewise all the phenomena of these, as of that of the year 1652 and of all the other preceding ones whose observations came into our hands, especially those bearing on the motion and those depending on it, could be duly and rightly saved; so that all the things said and asserted here and there in this work about past curly-haired stars [ſtellis cincinnatis] in general might also, by these, be the more elucidated and corroborated. Above all, since singular observations of these three comets, of no common kind, had been obtained by us with divine help granting it, on which we could securely rely.

[Margin: Cometæ 1661 obſervationes cum Theoriâ lib. X. exhi. bentur.] *The observations of the comet of 1661, with the theory, are presented in Book X.*

I have therefore fully decided to present in this tenth book the comet of 1661 and all its observations, and in the following eleventh book the two more recent comets and their theories;

[Margin: Quàm diuCometa ab Autore ſitobſervatus.] *How long the comet was observed by the author.*

considering that that [comet] was noticed by the others for only a few days, whereas it fell to me auspiciously, before all the others, as far as I have so far learned, to observe it from February 3 to March 28 as I wished.

Next, in our accustomed manner and by the method we rely on, to search out by calculation not only its motion in longitude and in latitude, but also its proper [motion], as accurately as possible, in order to establish its theory: namely, whether this comet too can be freed from all inconsistencies by the method set out in Book IX;

[Margin: Cometa 1661 admirandam exhibuit orbi. tam apparentem.] *The comet of 1661 showed an admirable apparent orbit.*

especially since, beyond all the others, it showed an admirable apparent motion and traced a wonderful course of its path in the heaven itself with respect to the fixed stars; of this kind I have truly found none like it so far, much less detected one myself, that described and pursued so curved a course, and then that, having traversed a very short space of the heaven, deflected so widely from the path of a great circle, by almost 25 or 26 degrees.

[Margin: Quanta fuerit hujus Cometæ deviatio à circulo maximo.] *How great this comet's deviation from a great circle was.*

Moreover, we shall take pains to bring out its genuine parallax, so that in this way we may also have the true distance of this comet from the Earth ascertained, for the greater knowledge and elucidation of cometographical contemplations.

[Margin: Calculi capita hoc libro tantùm traduntur.] *Only the heads of the calculation are given in this book.*

Yet I shall cover everything briefly; and although in this phenomenon too I have spared no labour, investigating everything, that is, by the strictest calculation, I shall nevertheless give only the heads of the calculation, in summary: presenting, namely, the givens and the products; everything according to that pattern shown in its place for the comets of 1664 and 1665 in our description and in the *Mantissa* of the *Prodromus*. But to come to the matter itself, let us, in our usual manner, first set out the general description of this comet, and also the particular observations themselves.

General History of the Comet of 1661 [Generalis Cometæ 1661 Hiſtoria.]

[Margin: Hiſtoria generalis Cometæ 1661 [[,/;]]] *General history of the comet of 1661.*

In the year from the birth of Christ 1661, on February 2, Gregorian style, at 10^h in the evening, when at last, after about five days had passed, the sky cleared again with the Circius [a north-westerly wind] blowing more strongly, we once more took up our accustomed labours: namely, observations of the fixed stars, on which we spent the whole night.

[Margin: Prima Cometæ apparitio.] *The first appearance of the comet.*

But very early in the morning, when we had set out our instruments towards the east to search out certain stars in the Vulture hitherto unknown, namely on February 3 at about 5^h in the morning, behold, in the same tract of the heaven, towards the Subsolanus [the east wind], a new, unusual and very rare phenomenon, bearing the appearance of a comet, below Delphinus, between the heads of Aquila and Equuleus, in ♒ 10° and 22° northern latitude, presents itself to our view.

[Margin: Quo loco initiò reſederit.] *In what place it stood at first.*

[Margin: Figura, color, & magnitudo capitis.] *The shape, colour and size of the head.*

The head was round, of a yellowish colour, bright and conspicuous, yet endowed with no twinkling light. By means of the telescope it showed in the middle of the head a reddish nucleus, almost equal to Jupiter himself, which, however, a far more diluted and thinner matter surrounded.

[Margin: Caudæ Lon. gitudo & Directio.] *The length and direction of the tail.*

It stretched out towards Delphinus a remarkable tail of six degrees, more or less, more compressed at its outlet by the head than about its end. For it gradually di- verged, so that at the end it appeared with spread-out and shaggy rays. As dawn grew stronger, however, it looked thinner, paler and shorter; nevertheless at half of the seventh [hour, that is, half past six] the comet itself was still seen with the naked eye, though stripped entirely of all its hair. Throughout the time it shone it was diligently observed with suitable and very large instruments, both from the fixed stars and from the planets.

[Margin: Situs Cometæ reſpectu quorundam Planetarum.] *The position of the comet with respect to certain planets.*

On this day, February 3, it was found towards the Hypereurus, a little below Venus, which stood in the Euroauster, while Saturn stood in the Auster [the south wind] and Jupiter in the Africus [the south-west wind]. With the aid of the tube, Venus shone with its face almost halved, Saturn with handles, and Jupiter with three companions, in roughly this order:

[Margin: Quâ facie Planetæ quidam apparuerint.] *In what aspect certain planets appeared.*

Diagram. A small figure set at the end of the line: Jupiter as an open ring, with one asterisk close to its left and a second asterisk lower and further to the left; after a gap to the right a third asterisk, and then a small dot level with the line, which may be the full point closing the sentence. The labels printed on it:

- above the ring: 1.
- above the gap between the ring and the right-hand asterisk: 6. *diam.*

On this day too the meridian altitude of the Sun was observed with our great azimuth quadrant: 19° 22′ 40″. At the same time we noticed a certain spot about the centre of the Sun, a little towards the west, in northern latitude; it had, however, already left the Sun completely by February 10.

[Margin: Cum altitudine Solis Me. rid. Macula Solaris quoque obſervata est.] *Together with the Sun's meridian altitude, a solar spot was also observed.*

On February 4, in the morning, a careful watch was indeed kept, but because clouds were then besetting the horizon in the place where the comet ought to have risen, nothing at all was accomplished by us. I had therefore resolved to turn my eyes to this phenomenon that same day in the evening, immediately after sunset. For since it had possessed a fairly evident northern latitude, there was no slight hope of viewing the comet in the evening as well; and this could very nearly have happened too, had the wholly cloudy air not stood in the way.

[Margin: Ob inſignem Latitudinem Borealem, potuiſſet Cometa & veſperi videri.] *Because of its marked northern latitude, the comet could have been seen in the evening as well.*

On the 5th, in the morning, under a very clear sky, the comet was observed exactly several times, but with a tail of only 4 degrees, and then with a sharper point. The head appeared somewhat larger and brighter, of a golden colour, yet with a duller light than the rest of the stars. That single nucleus, however, had by now been split into different parts, as can be seen on page 458, where we have placed its image.

[Margin: Ampliori capite, & breviori caudâ Cometa apparuit.] *The comet appeared with a larger head and a shorter tail.*

[Margin: Nucleus interior in diverſas partes abierat.] *The inner nucleus had gone off into different parts.*

Close to the head itself three little stars, not yet entered on the globes, were seen at a distance of about 20′ or 25′; of these the lower stood towards the Subsolanus, the more leftward towards the north, and the upper towards the Euronotus. Yet all of them, together with the phenomenon, were taken in by a single aperture of the tube, of about 50′.

[Margin: Stellulæ minutiores circa Cometam.] *Smaller little stars about the comet.*

In the evening, however, though the air was very clear, the comet was carefully sought but in no way shone forth: for neither Delphinus nor Aquila, where it was then lodged, came into our view any longer.

On February 6, in the morning, because of an illness that had seized me, I could not climb up to the observatory before the fifth hour; nevertheless it was adequately noted. It had a tail of almost equal length, as on the preceding day, except that it looked a little more pointed still, and also paler and dimmer.

[Margin: Cauda paullò acuminatior, & obſcurior viſa est.] *The tail looked a little more pointed and dimmer.*

Moreover, and mark this well, it darted frequent rays; for this reason the coma itself was observed now shorter, now longer. Through the tube, however, it was thinner and whiter, and fell between two little stars situated at the head of Aquila.

[Margin: Radios vibrabat frequentes.] *It darted frequent rays.*

The head still showed almost the same colour, not unlike, though somewhat duller than, the colour that the star in the shoulder of Aquila otherwise shows.

[Margin: Color Capi. tis.] *The colour of the head.*

The disc had partly decreased, and most of the nuclei too were smaller: of these, one in the lower part of the disc, on the left,

[Margin: Caput ex diverſiſſimis nucleis conſta. bat.] *The head consisted of the most diverse nuclei.*

stood out beyond all the rest as much denser and brighter, with a round body, like some very bright little star; other matter, as always, entirely surrounded these nuclei.

On February 7 it was again observed as we wished, in the presence of very many spectators, more than sixty, men most illustrious, noble, most distinguished and most learned. The head was now somewhat dimmer, and the nuclei more confused; yet they were found brighter in the lower part than in the upper. Its size otherwise, as regards the nuclei, was almost the same.

[Margin: Caput in dies obſcurius, nucleiq́; confuſio. res apparuerunt.] *The head grew dimmer day by day, and the nuclei appeared more confused.*

The tail was seen of only three degrees, and the comet threw it straight up from the horizon, erect like a column. At that time Jupiter shone with its four attendants in roughly this order:

[Margin: Cometa caudam planè erectam exhibuit.] *The comet showed its tail fully erect.*

Diagram. A small figure set at the end of the line, with no labels: from left to right an asterisk (more heavily inked than the others), an asterisk, an open ring for Jupiter, an asterisk close to the ring's right, and an asterisk further to the right; four asterisks in all.

[Margin: Obſervatio Jovialium.] *Observation of the Jovian [satellites].*

On February 8 and 9, when the comet was rising, the sky was completely covered with clouds, so that nothing whatever was detected.

On February 10, in the morning, with the clearness of the sky again favouring the undertaking, it went as we wished. The head, although of almost the same size, was already somewhat dimmer, and the nuclei more confused, yet they were found brighter in the lower part than in the upper. The coma too, a little thinner still and shorter, and more pointed, appeared to bend aside towards its end, its length scarcely exceeding two degrees.

[Margin: Evidentisſima alteratio in Cometæ capite animadverſa eſt,] *A most evident alteration was noticed in the comet's head.*

In it, near the point, a shining little star flashed out, namely the neck, or the head, of Aquila. For the rest, Jupiter on this day showed itself with 4 companions:

[Margin: Joviales denuò Tubo detecti ſunt.] *The Jovian [satellites] were again detected with the tube.*

Diagram. A small figure set within the line, with no labels: at the left a cluster of three asterisks (one set higher, two lower, the lower left one more heavily inked), then an open ring for Jupiter, then, after a wider gap, one asterisk; four asterisks in all.

Venus, however, [showed itself] with a much diminished diameter.

On February 11 and 12, clouds at one time and rain at another stood in the way of the observations, so that nothing at all was noted.

On February 13, at 4^{h} in the morning, the sky at last cleared again. But although the comet stood at a conspicuous altitude, yet because of the brightness of the almost full Moon the tail was scarcely detected with the naked eye; with the telescope, however, it did indeed meet the eyes, but equalling only half a degree in length; moreover it was very pale and dim.

[Margin: Præſente Lunâ nudis oculis cauda minimè, ſed Teleſcopio detecta eſt.] *With the Moon present, the tail was not detected at all with the naked eye, but [it was] with the telescope.*

The line of direction extended towards the south, about a degree away from the bright star in the shoulders of Aquila.

[Margin: Directio Caudæ.] *The direction of the tail.*

The head had decreased a great deal, in size as much as in brightness. As for the rest, what was observed regarding its position relative to the fixed stars is shown by the particular observations that follow. On this day, however, because of the thinness of its body, the comet was not detected by my assistant, who has somewhat duller sight, quite so accurately as on the preceding days; so I would readily concede that in one or another observation there was a slight deviation, by a minute more or less.

[Margin: Ob nimis de. bile lumen,Co. meta probisOr. ganis obſervari haud potuit.] *Because its light was too feeble, the comet could not be observed with proper instruments.*

On February 14, at 4^h in the morning, very thin little clouds covered almost the whole of Aquila. The comet was indeed seen with the naked eye, but not at all through the slits of the pinnules, so it could not be observed with the sextant. In a somewhat rougher way, therefore, namely with the naked eye, with respect to its various positions relative to the fixed stars, I set about exploring its place by means of stretched threads, rulers and other aids, by the better way, as far as it could be done. With the aid of the tube its face was still almost the same; but a faint trace of the tail was detected, because of the Moon's presence, I think.

On February 17, at 4^h, the comet was still of conspicuous magnitude, even with the Moon shining. For the nuclei almost equalled the diameter of Venus; but as regards the more diluted matter surrounding the head, the diameter of the phenomenon ran out to a full 2′ or 3′. In respect of light and colour it showed almost the same appearance, except that it was somewhat turbid, and faint with dullness.

[Margin: Magnitud[[o/ò]] Diametri Cometica, tam ratione nucleorum, quàm materiæ dilutioris adhærentis.] *The cometary magnitude of the diameter, both with respect to the nuclei and to the more diluted matter adhering [to them].*

Because of the obscurity of its body, however, it could not be observed with suitable instruments, except by stretched threads, triangles and straight lines, as is clear from the particular observations. It showed its tail somewhat brighter, and directed it (as far as one was able to judge) towards the Bright Star of Aquila.

[Margin: Cauda rursùs paullò lucidior.] *The tail again a little brighter.*

On the 18th and 19th, adverse weather in the sky utterly thwarted these most delightful contemplations of ours.

On February 20, the whole comet, together with its nuclei and the surrounding matter, [was] paler and fainter because of the Moon's brightness and nearness, and of the tail scarcely a faint trace was seen. Hence it was observed only roughly through the pinnules; what was detected besides, the following observations show.

On the 21st, 22nd, 23rd, 24th and 25th the sky stayed continuously cloudy.

On February 26, 27 and 28 and March 1, with the air very clear and the Moon absent, the comet appeared much brighter, but only like a little star of the fifth magnitude; yet it was already removed not a little from that northern star in the southern wing of Aquila, towards the last [star] of the tail of Serpens. Therefore, had I not been away from home on these days, the comet could duly have been observed again. With the telescope its diameter looked fairly large, though it was stripped of all tail.

[Margin: Cometa am. pliori Diame. tro, omni Comâ exutus viſus eſt.] *The comet was seen with a larger diameter, stripped of all coma.*

On March 2 I again measured the comet with the sextant, although it appeared somewhat dimmer than on the 26th and 27th. Yet it was still fairly conspicuous, of a magnitude, namely, of some minutes in diameter; but not

altogether round; moreover it was torn and scattered all round. With the telescope we detected quite distinctly a tail almost a degree long, inclining towards the upper of the unformed [stars] (next to the right shoulder of Serpentarius).

[Margin: Caput Come. ticum non abſolutam rotun. ditatem retulit.] *The comet's head did not show complete roundness.*

[Margin: Cauda revi. viſcit.] *The tail revives.*

From March 3 to 10, bad weather denied us the comet entirely.

On March 10, however, with the Moon present, the comet was indeed seen at once with the tube, but not at all with the naked eye; as the Moon was setting, however, the head appeared almost more distinctly than on March 2. Indeed, had the Moon at that time lain hidden deeper below the horizon, and had the comet not been stuck in the Milky Way among so many very small fixed stars, I would have hoped that it could be observed much more distinctly; although it was nevertheless detected with the sextant just as well as on March 2. Through the optical tube it showed almost the same magnitude, except that the whole body, with its nuclei, was duller and gloomier, stripped of all its hair. Close to the head itself three very small little stars, hitherto unknown, were seen, and indeed on the upper side, in roughly this position: namely, b was 15′ distant, c 10′, d 30′, and a only 2′.

[Margin: Caput triſtius, absque crini. bus inter mi. nutisſimas ſtel. lulas emicuit.] *The head, gloomier, without hair, flashed out among very small little stars.*

Diagram. A small figure set below the last line of text: an open ring for the comet; above it a row of three asterisks, each with a letter set just above it; and below and to the right of the ring a fourth asterisk with its letter set to its right. The labels printed on it:

- above the left-hand asterisk of the upper row: b
- above the middle asterisk of the upper row: c
- above the right-hand asterisk of the upper row: d
- to the right of the asterisk below and right of the ring: a

From this day, the 10th, to March 19, the sky did not favour observations at all. On the 19th, however, as the air cleared again, we went together with the excellent Boulliau, then by far our most welcome guest, to seek the comet, most diligently indeed; but we could find it neither with the naked eyes nor with the telescope.

[Margin: Quâ die Cometa nec nudo nec armato oculo deprehenſus ſit.] *On which day the comet was detected neither by the naked nor by the armed eye.*

On March 28, after the sky had stayed continuously cloudy up to then, I again pursued the comet carefully with the telescope, in the company of the distinguished Mr Boulliau; and not in vain. For at last I found it, although it was extremely pale and thin, above all in respect of its matter, and very much scattered, so that no nuclei at all were discerned separately, though its size had decreased little, as the delineations on page 458 attest.

[Margin: Autor Cometam ultimò cum Cl. Bullialdo obſervavit.] *The author observed the comet for the last time with the distinguished Boulliau.*

[Margin: Quâ facie tum apparu. erit.] *In what aspect it then appeared.*

On March 30, under a somewhat cloudy sky, it was no longer possible to detect the comet at all. From that time I gave up these observations altogether, content that I had observed the comet duly up to that point, so that we can explore its motion and course rightly and accurately, without doubt.

It was continuously retrograde; and in the first days indeed much swifter, having advanced 1° 24′ in the space of 24 hours, but at the last only 6′. Keeping its latitude and declination always northern, it held its course below Delphinus, through the head of Aquila, above its neck between the two little stars in its southern wing, up to the line that is drawn from the last [star] of Serpens to the right arm of Antinous, where at last it vanished at once, as is clear from the attached delineation.

[Margin: Cometa retrogradus, & curſu tardus extitit.] *The comet was retrograde, and slow in its course.*

[Margin: Qualem ſervaverit curſum apparentem.] *What apparent course it kept.*

In it you will at the same time find the path of its journey, or its apparent orbit, which is the most notable of [those of] all the other comets observed up to now, both by me and by those whose observations have fallen into our hands, because of its marked deflection from a great circle and its uncommon curving.

[Margin: Cometa hic præ cæteris omnibus valdè inſignem deſcripſit meatum.] *This comet, beyond all the others, described a very remarkable course.*

For this orbit is by no means a section of a great circle, but most evidently conic; and this deserves, just as it deserves to be well noted, to be rightly inquired into: whether the course and progress of this comet, like those of all the rest (Book IX), can be saved by a nearly straight line.

[Margin: An motus Cometæ rectâ lineà ſalvari poſſit ? inquirendum eſt.] *Whether the motion of the comet can be saved by a straight line: this is to be inquired into.*

It is worth the effort, therefore, first to add here the particular observations of this comet for all the days; and then to subject them also most diligently to calculation by our method, so that we may not be unable to explore and uncover exactly not only its motion in longitude, latitude, declination and right ascension, but also the angle of inclination of its orbit, the nodes, and its true proper motion, and no less, finally, its genuine parallaxes and its distances from the Earth, and other matters belonging here, and so to construct an accurate hypothesis of it.

As for the observations themselves, know, kind reader, that the altitudes of the fixed stars for correcting the time, and also the altitudes of the comet serving for the refractions, were observed sometimes with our very large horizontal brass quadrant, six or seven feet wide in radius, and sometimes also with a smaller hanging quadrant, which nevertheless showed single minutes. The distances of the comet from the fixed stars, on the other hand, were taken with

our very large bronze sextant, with what diligence was possible. All of these have been noted in order, faithfully and diligently, just as they fell out, with all correction and reduction (as is indeed rather often done) entirely removed. The first column gives the time estimated by the going clock [horologium ambulatorium]; the second, the altitudes and distances themselves; the third, the time corrected from the altitudes of the fixed stars; and the last, the distances freed from refractions.

[Margin: Quibus Inſtrumentis obſervationes ſunt peractæ.] *With which instruments the observations were made.*

Observations of the Comet of 1661, Made at Danzig in the Month of February and March by Johannes Hevelius [OBSERVATIONES COMETÆ 1661 Menſe Febr. & Martio GEDANI à JOHANNE HEVELIO peractæ.]

By the going clock, morning (h m s)	Thursday, February 3: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$5^h\ 29^m\ 30^s$	Altitude of Lyra for correcting the time.	50° 25′ 0″	$5^h\ 37^m\ 11^s$	
$5^h\ 30^m\ 45^s$	taken again.	50° 35′ 0″	$5^h\ 38^m\ 20^s$	
$5^h\ 33^m\ 30^s$	Distance of the comet from the Tail of Cygnus.	40° 30′ 0″	$5^h\ 41^m\ 18^s$	40° 35′ 55″
$5^h\ 35^m\ 30^s$	The same distance.	40° 30′ 15″	$5^h\ 43^m\ 22^s$	
$5^h\ 36^m\ 0^s$	Altitude of the comet, about.	7° 28′ 0″	$5^h\ 44^m\ 0^s$	
$5^h\ 44^m\ 0^s$	Distance of the comet from the Head of Serpentarius.	47° 12′ 40″	$5^h\ 52^m\ 18^s$	47° 17′ 34″
$5^h\ 46^m\ 30^s$	The same distance.	47° 13′ 15″	$5^h\ 54^m\ 54^s$	
$5^h\ 48^m\ 0^s$	Altitude of the comet, about.	9° 2′ 0″	$5^h\ 56^m\ 27^s$	
$5^h\ 50^m\ 0^s$	Distance of the comet from the second-to-last [star] of the Tail of Serpens.	36° 35′ 30″	$5^h\ 58^m\ 32^s$	36° 18′ 27″
	The same distance.	36° 35′ 30″		
$6^h\ 10^m\ 30^s$	Distance of the comet from the Tail of Cygnus.	40° 31′ 25″	$6^h\ 19^m\ 59^s$	40° 34′ 0″
	The same distance.	40° 31′ 25″		
$6^h\ 12^m\ 0^s$	Altitude of the comet, about.	12° 15′ 0″	$6^h\ 21^m\ 32^s$	
$6^h\ 15^m\ 40^s$	Altitude of the Tail of Cygnus for correcting the time.	43° 8′ 0″	$6^h\ 25^m\ 23^s$	
$6^h\ 18^m\ 30^s$	Altitude of the Bright Star of Aquila.	24° 13′ 0″	$6^h\ 28^m\ 14^s$	
$6^h\ 19^m\ 45^s$	Taken again.	24° 24′ 0″	$6^h\ 30^m\ 52^s$	

By the going clock, morning (h m s)	Saturday, February 5: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$4^h\ 33^m\ 10^s$	Altitude of Lyra for correcting the time.	42° 6′ 0″	$4^h\ 31^m\ 57^s$	
$4^h\ 34^m\ 10^s$	The same altitude.	42° 12′ 0″	$4^h\ 32^m\ 30^s$	
$4^h\ 41^m\ 0^s$	The comet's tail showed itself above the horizon to the naked eye.		$4^h\ 39^m\ 27^s$	
$4^h\ 42^m\ 0^s$	Altitude of the end of the tail seen above the horizon, about.	2° 45′ 0″	$4^h\ 40^m\ 27^s$	
$4^h\ 46^m\ 0^s$	Altitude of the comet.	2° 0′ 0″	$4^h\ 44^m\ 25^s$	
$5^h\ 0^m\ 30^s$	Distance of the comet from the Head of Serpentarius.	44° 12′ 45″	$4^h\ 58^m\ 49^s$	44° 21′ 18″
$5^h\ 3^m\ 40^s$	The same distance.	44° 12′ 25″	$5^h\ 1^m\ 57^s$	44° 20′ 48″
$5^h\ 4^m\ 30^s$	Altitude of the comet, about.	4° 18′ 0″	$5^h\ 2^m\ 46^s$	
$5^h\ 9^m\ 0^s$	Distance of the tip of the tail from the Head of Serpentarius.	40° 42′ 20″	$5^h\ 8^m\ 15^s$	
$5^h\ 14^m\ 0^s$	Distance of the comet from the Tail of Cygnus.	39° 34′ 55″	$5^h\ 14^m\ 13^s$	39° 42′ 5″
$5^h\ 18^m\ 40^s$	The same distance.	39° 33′ 25″	$5^h\ 17^m\ 1^s$	39° 40′ 27″
$5^h\ 19^m\ 20^s$	Altitude of the comet, about.	7° 15′ 0″	$5^h\ 17^m\ 40^s$	
$5^h\ 23^m\ 0^s$	Distance of the tip of the tail from the Tail of Cygnus.	35° 10′ 40″	$5^h\ 21^m\ 10^s$	
$5^h\ 28^m\ 45^s$	Distance of the comet from the outermost [star] of the wing of Cygnus; doubtful.	26° 16′ 45″	$5^h\ 26^m\ 52^s$	26° 20′ 15″
$5^h\ 31^m\ 0^s$	The same distance.	26° 16′ 25″	$5^h\ 29^m\ 5^s$	
$5^h\ 32^m\ 0^s$	Altitude of the comet.	8° 31′ 0″	$5^h\ 30^m\ 4^s$	
$5^h\ 38^m\ 40^s$	Distance of the comet from the second-to-last [star] of the Tail of Serpens.	33° 40′ 15″	$5^h\ 36^m\ 42^s$	33° 42′ 43″
$5^h\ 41^m\ 40^s$	The same distance.	33° 40′ 5″	$5^h\ 39^m\ 11^s$	
$5^h\ 48^m\ 0^s$	Distance of the comet from the Head of Serpentarius.	44° 13′ 0″	$5^h\ 45^m\ 58^s$	44° 16′ 38″
	The same distance	44° 13′ 0″		
$5^h\ 52^m\ 10^s$	Altitude of the comet	11° 34′ 0″	$5^h\ 50^m\ 6^s$	
$5^h\ 59^m\ 40^s$	Distance of the comet from the Tail of Cygnus	39° 40′ 45″	$5^h\ 57^m\ 33^s$	39° 43′ 15″
	The same distance	39° 40′ 45″		
$6^h\ 3^m\ 0^s$	Altitude of the comet	13° 10′ 0″	$6^h\ 0^m\ 51^s$	
$6^h\ 4^m\ 45^s$	Altitude of the Tail of Cygnus for correcting the time.	41° 15′ 0″	$6^h\ 3^m\ 29^s$	
$6^h\ 5^m\ 45^s$	The same altitude	41° 21′ 0″	$6^h\ 4^m\ 20^s$	

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By the going clock, morning (h m s)	Saturday, February 5: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$6^h\ 13^m\ 30^s$	Distance of the comet from Venus.	34° 47′ 35″	$6^h\ 11^m\ 18^s$	
$6^h\ 15^m\ 0^s$	Altitude of Venus, about.	3° 16′ 0″	$6^h\ 12^m\ 47^s$	
$6^h\ 15^m\ 45^s$	Altitude of the comet, about.	14° 58′ 0″	$6^h\ 13^m\ 31^s$	
$6^h\ 23^m\ 30^s$	Distance of the comet from the Head of Serpentarius; doubtful.	43° 51′ 50″	$6^h\ 21^m\ 6^s$	
	The same distance.	43° 51′ 50″		
$6^h\ 25^m\ 0^s$	Altitude of the comet, about.	16° 30′ 0″	$6^h\ 22^m\ 36^s$	
$6^h\ 34^m\ 30^s$	Altitude of the Tail of Cygnus. Hardly careful enough, because of the twilight.	45° 20′ 0″	$6^h\ 32^m\ 0^s$	
$6^h\ 41^m\ 15^s$	Altitude of Arcturus.	50° 0′ 0″	$6^h\ 38^m\ 54^s$	
$6^h\ 42^m\ 15^s$	The same altitude.	49° 52′ 0″	$6^h\ 40^m\ 12^s$	

By the going clock, morning (h m s)	Sunday, February 6: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$5^h\ 10^m\ 45^s$	Altitude of the Tail of Cygnus; doubtful.	33° 5′ 0″	$4^h\ 57^m\ 40^s$	
$5^h\ 12^m\ 40^s$	The same altitude.	33° 20′ 0″	$4^h\ 59^m\ 29^s$	

[628] Arrangement of the page. Under the title the page carries two ruled tables, one for each day, separated by a double rule, and no other text. Each table has five blocks: the time by the going clock in the morning (hours, minutes and seconds in separate columns on the page, joined here); a description of each observation, headed by the day; the distances and altitudes as observed (degrees, minutes and seconds, joined here); the time corrected from the altitudes of the fixed stars; and the distances corrected for refractions. The headings of each block stand over four lines on the page and are joined here in one heading row. The rows are grouped by printed rules (in the first table in twos and threes, in the second in fours and fives); the rules are not reproduced. A blank cell is blank on the page. The word for about (circ.) and the word for doubtful (dub.) stand at the right end of their description cells. In the second table the description of the third observation runs on into the column of distances and altitudes, where no figure is printed in that row. Some descriptions in the lower rows of the second table carry no closing point on the page, and the English follows that. The corrected values are printed as they stand on the page and have not been recomputed: in the first table the distance from the second-to-last star of the Tail of Serpens is 36° 35′ 30″ as observed and 36° 18′ 27″ as corrected, the only corrected distance on the page that is smaller than the observed one; and the difference between the corrected time and the clock time, which grows steadily in each table, departs from that course in a few rows (first table, last row; second table, the first row, the ninth and tenth rows, the eighteenth row and the last two rows).

By the going clock, morning (h m s)	Sunday, February 6: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$5^h\ 20^m\ 0^s$	Distance of the comet from the second-to-last [star] of the Tail of Serpens; doubtful.	32° 19′ 50″	$5^h\ 6^m\ 48^s$	32° 23′ 37″
$5^h\ 21^m\ 0^s$	The same distance. *	32° 19′ 55″	$5^h\ 8^m\ 48^s$	
$5^h\ 25^m\ 40^s$	Distance of the tip of the tail from the Head of Serpentarius.	39° 40′ 0″	$5^h\ 12^m\ 10^s$	
$5^h\ 33^m\ 15^s$	Distance of the comet from the Head of Serpentarius.	42° 37′ 45″	$5^h\ 19^m\ 32^s$	42° 40′ 25″
	The same distance.	42° 37′ 45″		
$5^h\ 41^m\ 15^s$	Distance of the comet from the Tail of Cygnus.	39° 22′ 50″	$5^h\ 27^m\ 18^s$	
$5^h\ 44^m\ 0^s$	The same distance.	39° 22′ 10″	$5^h\ 31^m\ 2^s$	
$5^h\ 46^m\ 0^s$	Taken again. *	39° 22′ 30″	$5^h\ 31^m\ 59^s$	39° 26′ 25″
$5^h\ 47^m\ 0^s$	Altitude of the comet, about.	10° 40′ 0″	$5^h\ 32^m\ 54^s$	
$5^h\ 50^m\ 0^s$	Distance of the tip of the tail from the Tail of Cygnus.	36° 47′ 0″	$5^h\ 35^m\ 48^s$	
$6^h\ 12^m\ 0^s$	Distance of the comet from the outermost [star] of the wing of Cygnus.	26° 38′ 15″	$5^h\ 57^m\ 10^s$	26° 40′ 0″
$6^h\ 13^m\ 0^s$	The same distance.	26° 38′ 15″	$5^h\ 58^m\ 8^s$	
$6^h\ 14^m\ 0^s$	Altitude of the comet, about.	15° 0′ 0″	$5^h\ 59^m\ 3^s$	
$6^h\ 21^m\ 0^s$	Distance of the comet from the Head of Serpentarius.	42° 38′ 50″	$6^h\ 5^m\ 58^s$	42° 40′ 42″
	The same distance.	42° 38′ 50″		
$6^h\ 30^m\ 0^s$	Distance of the comet from the Tail of Cygnus.	39° 27′ 15″	$6^h\ 14^m\ 40^s$	39° 28′ 40″
$6^h\ 31^m\ 0^s$	Altitude of the comet.	17° 0′ 0″	$6^h\ 15^m\ 38^s$	
$6^h\ 35^m\ 0^s$	Altitude of Lyra.	58° 18′ 0″	$6^h\ 19^m\ 34^s$	
$6^h\ 36^m\ 45^s$	The same altitude.	58° 30′ 0″	$6^h\ 21^m\ 2^s$	

By the going clock, morning (h m s)	Monday, February 7: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$3^h\ 49^m\ 0^s$	Altitude of Lyra.	36° 6′ 20″	$3^h\ 41^m\ 29^s$	
$3^h\ 51^m\ 45^s$	The same altitude.	36° 30′ 15″	$3^h\ 44^m\ 21^s$	
$4^h\ 21^m\ 30^s$	The tail first seen above the horizon.		$4^h\ 14^m\ 41^s$	
$4^h\ 44^m\ 0^s$	Distance of the tip of the tail from the Head of Serpentarius; doubtful.	38° 44′ 30″	$4^h\ 37^m\ 38^s$	
$4^h\ 51^m\ 0^s$	Distance of the comet from the Head of Serpentarius.	41° 15′ 15″	$4^h\ 44^m\ 47^s$	41° 21′ 55″
$4^h\ 53^m\ 25^s$	The same distance.	41° 13′ 20″	$4^h\ 47^m\ 15^s$	
$4^h\ 57^m\ 40^s$	Distance of the comet from the Tail of Cygnus.	39° 8′ 55″	$4^h\ 51^m\ 35^s$	39° 14′ 37″
$4^h\ 59^m\ 40^s$	The same distance.	39° 7′ 50″	$4^h\ 53^m\ 38^s$	

By the going clock, morning (h m s)	Monday, February 7: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$5^h\ 1^m\ 35^s$	Altitude of the comet, about.	7° 0′ 0″	$4^h\ 55^m\ 34^s$	
$5^h\ 3^m\ 50^s$	Distance of the tip of the tail from the Tail of Cygnus; doubtful.	36° 19′ 25″	$4^h\ 57^m\ 51^s$	
$5^h\ 18^m\ 30^s$	Distance of the comet from the outermost [star] of the wing of Cygnus.	26° 51′ 35″	$5^h\ 12^m\ 46^s$	
$5^h\ 20^m\ 45^s$	The same distance.	26° 49′ 0″	$5^h\ 15^m\ 3^s$	
$5^h\ 22^m\ 30^s$	Taken again. *	26° 50′ 20″	$5^h\ 16^m\ 51^s$	26° 52′ 30″
$5^h\ 23^m\ 26^s$	Altitude of the comet, about.	11° 3′ 0″	$5^h\ 17^m\ 50^s$	
$5^h\ 24^m\ 54^s$	Altitude of the Tail of Cygnus for correcting the time.	36° 51′ 0″	$5^h\ 19^m\ 11^s$	
$5^h\ 29^m\ 15^s$	Distance of the comet from the right knee of Pegasus.	41° 4′ 45″	$5^h\ 24^m\ 46^s$	
$5^h\ 30^m\ 20^s$	The same distance.	41° 4′ 30″	$5^h\ 24^m\ 52^s$	41° 4′ 45″
$5^h\ 33^m\ 25^s$	Taken again.	41° 4′ 30″	$5^h\ 28^m\ 0^s$	

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By the going clock, morning (h m s)	Monday, February 7: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$5^h\ 44^m\ 50^s$	Distance of the comet from the Bright Star of Lyra.	39° 56′ 40″	$5^h\ 39^m\ 40^s$	
$5^h\ 47^m\ 30^s$	The same distance.	39° 57′ 50″	$5^h\ 42^m\ 25^s$	40° 1′ 40″
$5^h\ 51^m\ 0^s$	Again	39° 57′ 50″	$5^h\ 46^m\ 0^s$	
$5^h\ 59^m\ 20^s$	Distance of the comet from the Head of Serpentarius; doubtful.	40° 58′ 25″	$5^h\ 54^m\ 25^s$	
$6^h\ 1^m\ 35^s$	Altitude of the comet, about.	15° 30′ 0″	$5^h\ 56^m\ 44^s$	

[629] Arrangement of the page. The page carries only tables, set in one ruled frame: the end of the observations of 5 February, continued from the preceding page, and those of 6 and 7 February, each day under its own heading and closed by a double rule. The columns are those of the preceding page, joined here in the same way, and the group rules are not reproduced. A blank cell is blank on the page. Three description cells end with a printed asterisk, reproduced as it stands; the page does not say what it marks. The heading of the time-corrected column for 7 February misprints its first word (Tompus for Tempus), and one description in that day reads dtſtantia for diſtantia; the English renders both as intended. The values are printed as they stand and have not been recomputed: the difference between clock time and corrected time, which changes steadily through each day, departs from its course in a few rows (5 February, the last two rows; 6 February, the fourth and ninth rows; 7 February, the sixteenth row). On 7 February the corrected distance 41° 4′ 45″ stands in the row of the second reading from the right knee of Pegasus and equals the first reading.

By the going clock, morning (h m s)	Monday, February 7: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$6^h\ 5^m\ 25^s$	Distance of the comet from the Tail of Cygnus; doubtful.	39° 11′ 0″	$6^h\ 0^m\ 39^s$	39° 11′ 22″
$6^h\ 10^m\ 25^s$	Altitude of the comet, about.	17° 15′ 0″	$6^h\ 5^m\ 45^s$	
$6^h\ 12^m\ 15^s$	Altitude of the Tail of Cygnus; doubtful.	43° 22′ 20″		
$6^h\ 14^m\ 20^s$	The same altitude. *	43° 39′ 5″		
$6^h\ 40^m\ 40^s$	Altitude of Arcturus.	48° 59′ 0″	$6^h\ 36^m\ 31^s$	
$6^h\ 41^m\ 30^s$	The same altitude.	48° 52′ 0″	$6^h\ 37^m\ 42^s$	

By the going clock, morning (h m s)	Thursday, February 10: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$4^h\ 23^m\ 50^s$	Altitude of Lyra.	41° 43′ 0″	$4^h\ 9^m\ 35^s$	
$4^h\ 24^m\ 45^s$	The same altitude.	41° 57′ 0″	$4^h\ 11^m\ 12^s$	
$4^h\ 53^m\ 30^s$	Distance of the comet from the Head of Serpentarius.	37° 23′ 45″	$4^h\ 39^m\ 30^s$	37° 28′ 15″
$4^h\ 55^m\ 45^s$	Taken again.	37° 23′ 5″	$4^h\ 41^m\ 45^s$	
$4^h\ 56^m\ 30^s$	Altitude of the comet, about.	9° 30′ 0″	$4^h\ 42^m\ 25^s$	
$5^h\ 2^m\ 40^s$	Distance of the comet from the Tail of Cygnus.	39° 5′ 30″	$4^h\ 48^m\ 30^s$	39° 8′ 50″
$5^h\ 5^m\ 15^s$	The same distance.	37° 5′ 30″	$4^h\ 51^m\ 5^s$	
$5^h\ 10^m\ 0^s$	Distance of the comet from the outermost [star] of the southern wing of Cygnus.	28° 7′ 15″	$4^h\ 55^m\ 45^s$	28° 8′ 30″
$5^h\ 12^m\ 0^s$	The same distance.	28° 7′ 11″	$4^h\ 57^m\ 45^s$	
$5^h\ 16^m\ 30^s$	Distance of the comet from the right knee of Pegasus.	43° 33′ 30″	$5^h\ 2^m\ 12^s$	43° 33′ 30″
$5^h\ 19^m\ 0^s$	The same distance.	43° 32′ 50″	$5^h\ 4^m\ 42^s$	
$5^h\ 29^m\ 0^s$	Distance of the comet from the Bright Star of Lyra.	37° 40′ 20″	$5^h\ 14^m\ 40^s$	37° 43′ 32″
$5^h\ 33^m\ 0^s$	The same distance.	37° 39′ 30″	$5^h\ 19^m\ 40^s$	
$5^h\ 35^m\ 0^s$	Altitude of the comet, about.	15° 0′ 0″	$5^h\ 20^m\ 35^s$	
$5^h\ 42^m\ 30^s$	Distance of the comet from the Tail of Cygnus.	39° 7′ 45″	$5^h\ 28^m\ 5^s$	39° 9′ 22″
$5^h\ 44^m\ 15^s$	The same distance.	39° 7′ 20″	$5^h\ 29^m\ 50^s$	
$5^h\ 46^m\ 0^s$	Altitude of the comet.	16° 0′ 0″	$5^h\ 31^m\ 32^s$	
$5^h\ 50^m\ 45^s$	Distance of the comet from the Head of Serpentarius; doubtful.	37° 31′ 35″	$5^h\ 36^m\ 17^s$	37° 33′ 2″
	The same distance; doubtful.	37° 31′ 35″		
$5^h\ 55^m\ 0^s$	Altitude of the comet, about.	17° 50′ 0″	$5^h\ 41^m\ 30^s$	
$6^h\ 0^m\ 0^s$	Distance of the comet from the lower [star] in the right hand of Serpentarius.	35° 39′ 5″	$5^h\ 45^m\ 30^s$	35° 39′ 10″
$6^h\ 3^m\ 0^s$	The same distance.	35° 39′ 0″	$5^h\ 48^m\ 30^s$	
$6^h\ 4^m\ 5^s$	Altitude of the comet, about.	18° 50′ 0″	$5^h\ 49^m\ 0^s$	

By the going clock, morning (h m s)	Thursday, February 10: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$6^h\ 5^m\ 0^s$	Altitude of the lower [star] in the right hand of Serpentarius, about.	20° 0′ 0″	$5^h\ 51^m\ 25^s$	
$6^h\ 10^m\ 15^s$	Distance of the comet from the Head of Serpentarius; doubtful.	37° 17′ 40″	$5^h\ 55^m\ 35^s$	
	The same distance.	37° 17′ 40″		
$6^h\ 16^m\ 40^s$	Distance of the comet from the Tail of Cygnus; doubtful because of the dawn.	39° 7′ 5″	$6^h\ 1^m\ 55^s$	
$6^h\ 17^m\ 30^s$	Altitude of the comet, about.	21° 25′ 0″	$6^h\ 2^m\ 45^s$	
$6^h\ 21^m\ 30^s$	Altitude of the Tail of Cygnus.	44° 25′ 55″	$6^h\ 6^m\ 47^s$	
$6^h\ 24^m\ 30^s$	The same altitude.	44° 49′ 40″	$6^h\ 9^m\ 39^s$	

By the going clock, morning (h m s)	Sunday, February 13: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$4^h\ 19^m\ 45^s$	Altitude of Lyra.	44° 43′ 0″	$4^h\ 18^m\ 27^s$	
$4^h\ 21^m\ 0^s$	The same altitude.	44° 51′ 0″	$4^h\ 19^m\ 22^s$	
$4^h\ 28^m\ 0^s$	Distance between the Tail of Cygnus and the comet.	39° 27′ 0″	$4^h\ 26^m\ 30^s$	
$4^h\ 34^m\ 0^s$	The same distance.	39° 28′ 45″	$4^h\ 32^m\ 30^s$	39° 30′ 32″

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[630] Arrangement of the page. The page carries only tables, set in one ruled frame: the end of the observations of 7 February, continued from the preceding page, and those of 10 and 13 February, each day under its own heading; the last block has four rows, and the frame runs on empty below it. The columns are those of the preceding pages, joined here in the same way, and the group rules are not reproduced. A blank cell is blank on the page. One description cell ends with a printed asterisk, reproduced as it stands; the page does not say what it marks. The values are printed as they stand and have not been recomputed. The difference between clock time and corrected time, which changes steadily through each day, departs from its course in a few rows (10 February, the second, thirteenth, twentieth, twenty-third and twenty-fourth rows; 13 February, the first row). On 10 February the second reading from the Tail of Cygnus is printed as 37° 5′ 30″ against 39° 5′ 30″ for the first, and the corrected distance from the right knee of Pegasus equals the observed one. On 7 and 13 February the corrected distance stands in the row of the second reading of its pair.

By the going clock, morning (h m s)	Sunday, February 13: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$4^h\ 47^m\ 0^s$	Distance of the comet from the elbow of the lower wing of Cygnus.	29° 19′ 0″	$4^h\ 45^m\ 30^s$	
$4^h\ 51^m\ 0^s$	The same distance. *	29° 17′ 0″	$4^h\ 49^m\ 50^s$	29° 18′ 43″
$5^h\ 4^m\ 0^s$	Distance of the comet from the elbow of the upper wing of Cygnus.	38° 9′ 30″	$5^h\ 3^m\ 0^s$	
$5^h\ 8^m\ 30^s$	The same distance.	38° 5′ 30″	$5^h\ 7^m\ 40^s$	38° 7′ 0″
$5^h\ 11^m\ 30^s$	Taken again.	38° 5′ 30″	$5^h\ 10^m\ 50^s$	
$5^h\ 34^m\ 0^s$	Distance of the comet from the elbow of the lower wing of Cygnus. *	29° 17′ 45″	$5^h\ 34^m\ 0^s$	
	The same distance.	29° 18′ 0″		
$5^h\ 44^m\ 0^s$	Altitude of the Tail of Cygnus.	42° 57′ 0″	$5^h\ 44^m\ 24^s$	
$5^h\ 45^m\ 0^s$	The same altitude.	43° 5′ 0″	$5^h\ 45^m\ 17^s$	
$5^h\ 49^m\ 0^s$	Distance of the comet from the elbow of the upper wing of Cygnus.	38° 6′ 30″	$5^h\ 49^m\ 20^s$	
$5^h\ 50^m\ 0^s$	The same distance.	38° 6′ 30″	$5^h\ 50^m\ 25^s$	
$5^h\ 52^m\ 30^s$	Altitude of the comet.	22° 10′ 0″	$5^h\ 53^m\ 0^s$	
$5^h\ 54^m\ 40^s$	Altitude of Aquila.	25° 15′ 0″	$5^h\ 56^m\ 8^s$	
	The shoulder and the Bright Star of Aquila were seen in a straight line with the comet. The distance of the comet from the Bright Star and the distance of the shoulder from the Bright Star were equal. But the distance of the comet from the Bright Star and the distance of the comet from the neck of Aquila were found to be in a nearly fourfold ratio.			

By the going clock, morning (h m s)	Monday, February 14: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$5^h\ 0^m\ 0^s$	Distance of the comet from the neck of Aquila: the distance between the two fixed stars in the northern foot of Cygnus was equal to it.		$4^h\ 54^m\ 0^s$	
$5^h\ 18^m\ 0^s$	Altitude of Lyra.	53° 26′ 0″	$5^h\ 14^m\ 17^s$	
$5^h\ 21^m\ 0^s$	Altitude of the comet.	19° 15′ 0″		
$5^h\ 26^m\ 0^s$	The comet formed an equilateral triangle with the bright [star] in the shoulder blades and the [star] following the bright one. The base was the Bright Star of Aquila and the [star] following the bright one.		$5^h\ 22^m\ 0^s$	
	The comet's distance from the Bright Star and its distance from the Neck were in the sesquialteral ratio, that is, 2 to 3.			
$5^h\ 39^m\ 30^s$	Altitude of the comet, about.	22° 12′ 0″	$5^h\ 39^m\ 0^s$	
$5^h\ 41^m\ 0^s$	Altitude of Lyra.	57° 9′ 0″	$5^h\ 40^m\ 48^s$	

By the going clock, morning (h m s)	Thursday, February 17: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$4^h\ 41^m\ 0^s$	The Bright Star of Aquila, the comet and the right arm of Antinous in a straight line.		$4^h\ 48^m\ 0^s$	
	A star of the fifth magnitude, 1½° from the Bright Star of Aquila and 1° from the comet, kept a straight line with the Bright Star and the comet.			
	That star of the fifth magnitude was about 2° from the neck of Aquila, and 1° from the comet.			
	The neck of Aquila, the comet and the Bright Star of Aquila formed an isosceles triangle, such that the base, neck and comet, was the longest side, and the legs were Bright Star and neck, and Bright Star and comet; the former, however, was somewhat greater than the latter.			
$4^h\ 41^m\ 0^s$	The distance of the comet from the Bright Star of Aquila was somewhat smaller than the distance between the Bright Star and the neck, but somewhat greater than the distance between the Bright Star and the shoulder of Aquila.		$4^h\ 48^m\ 0^s$	
	The larger star of the 4th magnitude in the southern wing of Aquila, the northern preceding one, the comet and the neck were observed in roughly a straight line, such that the distance of the comet from the star in the wing was greater than the distance of the comet from the neck.			
$5^h\ 5^m\ 0^s$	Altitude of the Tail of Cygnus.	40° 45′ 0″	$5^h\ 12^m\ 46^s$	
$5^h\ 8^m\ 0^s$	Altitude of the comet.	21° 30′ 0″	$5^h\ 16^m\ 0^s$	

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[631] Arrangement of the page. The page carries only tables, set in one ruled frame: the end of the observations of 13 February, continued from the preceding page, and those of 14 and 17 February, each day under its own heading. The columns are those of the preceding pages, joined here in the same way, and the group rules are not reproduced. A blank cell is blank on the page. Several descriptions are notes of two to five lines describing the comet's place among the stars by straight lines, triangles and ratios of distances; they are set in italic like the other descriptions, except the last note of 13 February, which is in roman, and the rows of those notes carry figures only where the page prints them. Two description cells of 13 February end with a printed asterisk, reproduced as it stands; the page does not say what it marks. In the triangle note of 17 February the page misprints the word for triangle and repeats the first syllables of the word for somewhat across a line end; the English renders both as intended. The values are printed as they stand and have not been recomputed. The difference between clock time and corrected time, which changes steadily through each day, departs from its course in a few rows (13 February, the ninth and thirteenth rows; 14 February, the first and fourth rows); on 17 February the first and fifth rows give the same clock time and the same corrected time. On 13 February each corrected distance stands in the row of the second reading of its pair, as on the preceding page; the observations of 14 and 17 February carry no corrected distance.

By the going clock, morning (h m s)	Thursday, February 17: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
	The apparent diameter of the comet was almost equal to the diameter of ♃ [Jupiter]. It extended its tail towards the bright [star] of the Tail of Aquila, yet in such a way that it seemed to graze this star with its eastern edge. The light and colour of the comet were diminished little or not at all.			
$5^h\ 13^m\ 45^s$	Altitude of the Bright Star of Aquila.	22° 31′ 0″	$5^h\ 20^m\ 36^s$	

By the going clock, morning (h m s)	Sunday, February 20: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$3^h\ 9^m\ 15^s$	Altitude of Lyra.	39° 14′ 0″	$3^h\ 13^m\ 10^s$	
$3^h\ 12^m\ 0^s$	The same altitude.	39° 42′ 0″	$3^h\ 16^m\ 28^s$	
	The comet was distant from the northern star of the southern wing.	1° 0′ 0″	With the larger tube.	
	And from the more southern [star].	1° 30′ 0″		
	Above this one, towards the south, some new star stood off.	1° 0′ 0″		
	From this star the comet was distant towards the east.	0° 45′ 0″		
	The northern [star] in the southern wing of Aquila, the two in the tail, and the comet formed nearly a straight line; and so did the shoulder and the right arm of Antinous, with the point that lies between the comet and the northern [star] of the southern wing.			
$4^h\ 45^m\ 5^s$	Distance of the comet from the elbow of the southern wing of Cygnus.	31° 8′ 0″	$4^h\ 49^m\ 20^s$	
$4^h\ 49^m\ 0^s$	The same distance.	31° 2′ 0″	$4^h\ 53^m\ 20^s$	
$4^h\ 56^m\ 0^s$	Distance of the comet from the elbow of the northern wing of Cygnus.	38° 10′ 30″	$5^h\ 0^m\ 20^s$	
$4^h\ 58^m\ 0^s$	The same distance.	38° 11′ 25″	$5^h\ 2^m\ 0^s$	
$5^h\ 0^m\ 0^s$	Altitude of the comet, about.	23° 0′ 0″	$5^h\ 4^m\ 20^s$	
$5^h\ 2^m\ 30^s$	Distance of the comet from the Tail of Cygnus.	40° 40′ 0″	$5^h\ 7^m\ 0^s$	
	Distance of the comet from the Bright Star of Aquila, about.	3° 45′ 0″		
$5^h\ 11^m\ 40^s$	Altitude of the Tail of Cygnus.	42° 46′ 0″	$5^h\ 16^m\ 2^s$	
$5^h\ 12^m\ 30^s$	The same altitude.	42° 55′ 0″	$5^h\ 17^m\ 47^s$	
$5^h\ 14^m\ 0^s$	Repeated.	43° 4′ 0″	$5^h\ 18^m\ 12^s$	

By the going clock, morning (h m s)	Wednesday, March 2: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$3^h\ 55^m\ 0^s$	Altitude of the Tail of Cygnus.	36° 44′ 0″	$3^h\ 53^m\ 24^s$	
	Distance of the comet from the outermost [star] of the southern wing of Cygnus.	35° 21′ 0″	$3^h\ 52^m\ 0^s$	
	The same distance.	35° 21′ 0″		
$4^h\ 7^m\ 0^s$	The comet and the Tail of Cygnus.	42° 55′ 15″	$4^h\ 3^m\ 0^s$	
	The same distance.	42° 55′ 15″		
$4^h\ 17^m\ 0^s$	Altitude of the Tail of Cygnus.	39° 1′ 0″	$4^h\ 10^m\ 42^s$	
	Distance of the comet from the elbow of the northern wing of Cygnus.	39° 38′ 0″		
	The same distance.	39° 38′ 0″		
$4^h\ 34^m\ 0^s$	Altitude of the Tail of Cygnus.	41° 12′ 0″	$4^h\ 27^m\ 0^s$	
	Altitude of the comet, about.	24° 30′ 0″		
$4^h\ 34^m\ 0^s$	Distance of the comet from the Bright Star of Lyra.	34° 41′ 5″	$4^h\ 27^m\ 0^s$	
	The same distance.	34° 41′ 5″		
$4^h\ 47^m\ 0^s$	Distance of the comet from the Tail of Cygnus; doubtful.	42° 58′ 20″	$4^h\ 41^m\ 0^s$	
	The same distance. *	42° 55′ 45″		
$4^h\ 56^m\ 0^s$	Distance of the comet from the outermost [star] of the southern wing of Cygnus; doubtful.	35° 12′ 30″	$4^h\ 51^m\ 0^s$	
	The same distance. *	35° 16′ 20″		
$5^h\ 3^m\ 0^s$	Altitude of the Tail of Cygnus.	45° 32′ 0″	$4^h\ 58^m\ 22^s$	
	Not far from the comet, some unknown fixed [star] towards the south was found nearly in the same straight line with the comet and the Bright Star of Lyra, and at a distance of about 15′.			

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[632] Arrangement of the page. The page carries only tables, set in one ruled frame: the end of the observations of 17 February, continued from the preceding page under a heading of its own, and those of 20 February and 2 March, each day under its own heading. The columns are those of the preceding pages, joined here in the same way, and the group rules are not reproduced. A blank cell is blank on the page. Several descriptions are notes of two to four lines; they are set in italic like the other descriptions, except the last note of 2 March, which is in roman, and the rows of those notes carry figures only where the page prints them. On 17 February the first note ends with the astronomical sign of Jupiter. On 20 February the words for with the larger tube stand in the column of corrected times, beside the four short distances from neighbouring stars, and no corrected time is printed in those rows. Two description cells of 2 March end with a printed asterisk, reproduced as it stands; the page does not say what it marks. The values are printed as they stand and have not been recomputed. The difference between clock time and corrected time, which changes steadily through each day, departs from its course in a few rows (17 February, the fourth row against the preceding page; 20 February, the second, eleventh and sixteenth rows; 2 March, the first row); on 2 March the ninth and eleventh rows give the same clock time and the same corrected time, and the second row gives a corrected time with no clock time. No table on this page prints a corrected distance.

By the going clock, morning (h m s)	Thursday, March 10: the comet observed	Distances and altitudes (° ′ ″)	Time corrected from the altitudes (h m s)	Distances corrected for refractions (° ′ ″)
$2^h\ 45^m\ 0^s$	Altitude of the Tail of Cygnus	30° 10′ 0″	$2^h\ 36^m\ 20^s$	
$2^h\ 55^m\ 0^s$	Distance of the comet and [the star] in the elbow of the northern wing of Cygnus	40° 34′ 20″	$2^h\ 52^m\ 0^s$	40° 36′ 35″
	The same distance.	40° 34′ 20″		
$3^h\ 2^m\ 0^s$	Distance of the comet from the Tail of Cygnus	44° 19′ 0″	$3^h\ 1^m\ 0^s$	44° 20′ 4″
	The same distance	44° 19′ 0″		
$3^h\ 3^m\ 0^s$	Altitude of the comet, about.	22° 20′ 0″	$3^h\ 6^m\ 0^s$	
$3^h\ 15^m\ 0^s$	Distance of the comet from the outermost [star] of the southern wing of Cygnus.	37° 22′ 40″	$3^h\ 17^m\ 0^s$	37° 22′ 38″
	The same distance.	37° 22′ 40″		
$3^h\ 29^m\ 0^s$	Distance of the comet from the Bright Star of Lyra.	34° 47′ 0″	$3^h\ 30^m\ 0^s$	
	The same distance.	34° 47′ 0″		
$3^h\ 35^m\ 0^s$	Distance of the comet from the Tail of Cygnus.	44° 24′ 10″	$3^h\ 36^m\ 0^s$	
$3^h\ 40^m\ 0^s$	Altitude of the Bright Star of Aquila.	25° 12′ 0″	$3^h\ 41^m\ 35^s$	

By the going clock, morning (h m s)	Sunday, March 28: the comet observed with a very long tube.
$2^h\ 15^m\ 0^s$	From 10 March up to this day the sky was continuously so cloudy that nothing at all could be noticed of the comet. Between 27 and 28 March, however, a very clear night shone, so that very many fixed stars, together with the planets, were observed with suitable instruments, and also the comet itself, though only with an optical tube, and that of no ordinary kind; and this in the presence, and with the witness, of the excellent and most celebrated man Mr Ismaël Boulliau, a supreme astronomer, whom I then had as a guest in my house, most eagerly awaited, and on whose visit I greatly congratulate myself. The comet was indeed very pale and thin, yet fairly conspicuous as to its diameter. It stood near a little star unknown until now, and indeed a little above it, towards the left, in roughly a straight line between the right arm of Antinous and the last [star] of the Tail of Serpens; and likewise between the Bright Star of Aquila and the second-to-last [star] of the Tail of Serpens. This is what could be observed of the comet of 1661 here at Danzig.

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Further observations of this comet I could not obtain, because of the adverse weather, the shining Moon and other obstacles. From these, therefore, let us now explore by due calculation, following our method, the things that are worth knowing.

[Margin: Cometa utplurimùm in refractione deprehenſu eſt.] *The comet was found for the most part in refraction.*

Since this phenomenon, from its first beginning to its exit, stood for the most part within the refraction, and indeed sometimes sank right down to the horizon itself, it is altogether necessary that the bare distances first be purged of all refraction, if you would work to draw out the genuine and true place of the comet and, from it, the parallaxes that belong to it; as you see we did in the *Description of the Comet of 1665*, and also in the *Mantissa* of the *Prodromus*.

[Margin: Quâ ratione diſtantiæ à refractione depurgandæ ſint, alibi traditum eſt.] *How distances are to be purged of refraction has been explained elsewhere.*

But how these are to be explored was shown more than enough on page 18 of the *Descript. Comet.* 1665, so that there is no need at all to set down some example here, much less the whole series of the calculation. It will be enough to exhibit in Table A the data and the results, in our manner, provided that we first set out the places of certain fixed stars that serve this calculation, and no less another table [giving] the various times of several days, the place of the Sun, the right ascension, the right ascension of the midheaven, and also, for certain fixed stars from which the distances were taken, their right ascension, distance from the meridian and altitude, found by calculation.

[Margin: Loca quarundam Fixarum Solisq́; exhibentur.] *The places of certain fixed stars and of the Sun are given.*

Table showing the position of certain fixed stars with respect to the ecliptic, for the year 1661, in the month of February.

Names of the fixed stars	Longitude	Latitude
Tail of Cygnus.	0° 44′ 36″ ♓	59° 56′ 30″ B.
Head of Serpentarius.	17° 41′ 6″ ♐	35° 57′ 0″ B.

633 Arrangement of the tables. The page opens with two tables in one ruled frame: the observations of 10 March, in the columns of the preceding pages, joined here in the same way, with the group rules not reproduced; and the single observation of 28 March, whose heading gives only the clock column and the date, with a note in roman set across the rest of the frame, so it is given here in two columns. A blank cell is blank on the page. In the heading of 10 March the unit line of the distances is misprinted as hours, minutes and seconds; the English follows the other tables. The seconds of the last altitude of 10 March is a damaged sort, read as 0. The values are printed as they stand and have not been recomputed. On 10 March the difference between clock time and corrected time departs from its course in the first and sixth rows; each corrected distance stands in the row of the first reading of its pair, and the last of them is 2″ smaller than the observed distance. The second table is headed Sunday, though the note speaks of the night between 27 and 28 March.

Names of the fixed stars	Longitude	Latitude
Second-to-last [star] of the Tail of Serpens.	1° 3′ 36″ ♑	20° 37′ 30″ B.
Outermost [star] of the wing of Cygnus.	28° 24′ 16″ ♒	43° 44′ 0″ B.
Lyra.	10° 34′ 6″ ♑	61° 47′ 30″ B.
Right knee of Pegasus.	21° 2′ 29″ ♓	35° 8′ 4″ B.
Lower [star] in the right hand of Serpentarius.	25° 4′ 36″ ♐	13° 47′ 0″ B.
In the elbow of the lower wing of Cygnus.	23° 0′ 6″ ♒	49° 26′ 0″ B.
Mouth of Pegasus.	37° 13′ 6″ ♒	22° 7′ 30″ B.
In the elbow of the upper wing of Cygnus.	11° 44′ 6″ ♒	64° 28′ 0″ B.
Shoulder of Aquila.	26° 17′ 6″ ♑	31° 18′ 0″ B.
Bright Star of Aquila.	27° 0′ 6″ ♑	29° 21′ 30″ B.
Neck of Aquila.	27° 44′ 6″ ♑	26° 49′ 30″ B.
Small [star] following the Bright Star.	27° 56′ 57″ ♑	28° 53′ 44″ B.
Leading [star] in the northern foot of Cygnus.	23° 41′ 6″ ♒	63° 37′ 0″ B.
The following [star].	25° 25′ 36″ ♒	64° 17′ 30″ B.
Left shoulder.	18° 42′ 6″ ♒	8° 42′ 0″ B.

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In the year 1661.

Names of the fixed stars	Time before noon (h m s)	Place of the Sun	Right ascension of the Sun (° ′ ″)	Right ascension of the midheaven (° ′ ″)	Right ascension of the stars (° ′ ″)	Distance of the stars from the meridian (° ′ ″)	Altitude (° ′ ″)
			February 3	Morning.			
Tail of Cygnus.	5h 41m 18s	15° 1′ 58″ ♒	317° 30′ 37″	222° 50′ 7″	307° 29′ 45″	84° 39′ 38″	37° 13′ 0″
Head of Serpentarius.	5h 52m 18s	15° 2′ 26″ ♑	301′ 6″	225° 35′ 36″	259° 47′ 52″	34° 12′ 16″	40° 36′ 10″
Second-to-last [star] of the Tail of Serpens.	5h 58m 32s	15° 2′ 39″ ♑	301′ 19″	227° 9′ 19″	270° 59′ 35″	43° 50′ 16″	22° 15′ 11″
Tail of Cygnus.	6h 19m 59s	15° 3′ 33″ ♑	32′ 13″	232° 31′ 58″	307° 29′ 45″	74° 57′ 47″	42° 24′ 22″
			February 5	Morning.			
Head of Serpentarius.	4h 58m 49s	17° 2′ 27″ ♑	16° 29′ 38″	214° 11′ 53″	259° 47′ 52″	45° 35′ 59″	35° 20′ 40″
Tail of Cygnus.	5h 14m 13s	17° 2′ 56″ ♑	30′ 16″	218° 3′ 31″	307° 29′ 45″	89° 26′ 14″	34° 45′ 7″
Outermost [star] of the southern wing of Cygnus.	5h 26m 52s	17° 3′ 21″ ♑	30′ 45″	221° 13′ 45″	314° 47′ 0″	93° 33′ 15″	21° 11′ 57″

634 Arrangement of the first table. The page sets the longitude in degrees, minutes and seconds followed by the sign, and the latitude in degrees, minutes and seconds followed by B. (northern), in separate columns; each is joined here into one cell. The rule groups are not reproduced. In the row for the Mouth of Pegasus the longitude is printed with 37 degrees, more than the 30 degrees of a sign; it is given as printed. The last row names a left shoulder without naming the constellation.

Names of the fixed stars	Time before noon (h m s)	Place of the Sun	Right ascension of the Sun (° ′ ″)	Right ascension of the midheaven (° ′ ″)	Right ascension of the stars (° ′ ″)	Distance of the stars from the meridian (° ′ ″)	Alti-tude (° ′ ″)
Second-to-last [star] of the Tail of Serpens.	5h 36m 42s	17° 3′ 44″	331° 10″	223° 41′ 40″	270° 59′ 35″	47° 17′ 55″	20° 42′ 35″
Head of Serpentarius.	5h 45m 58s		331′ 33″	226° 1′ 3″	259° 47′ 52″	33° 46′ 49″	40° 46′ 52″
Tail of Cygnus.	5h 57m 33s	17° 4′ 13″	332′ 2″	228° 55′ 17″	307° 29′ 45″	78° 34′ 28″	40° 26′ 43″
Head of Serpentarius.	6h 21m 6s	17° 5′ 13″	33′ 1″	234° 49′ 31″	259° 47′ 52″	24° 58′ 21″	44° 5′ 54″
			February 6	Morning.			
Second-to-last [star] of the Tail of Serpens.	5h 6m 48s	18° 2′ 55″	♑ 30′ 3″	217° 12′ 3″	270° 59′ 35″	53° 47′ 32″	17° 37′ 22″
Head of Serpentarius.	5h 19m 32s	18° 3′ 2″	30′ 10″	217° 53′ 10″	259° 47′ 52″	41° 54′ 42″	37° 8′ 20″
Tail of Cygnus.	5h 31m 59s	18° 3′ 56″	31′ 3″	223° 30′ 48″	307° 29′ 45″	83° 58′ 57″	37° 34′ 13″
Outermost [star] of the southern wing of Cygnus.	5h 57m 10s	18° 5′ 0″	32′ 6″	229° 49′ 36″	314° 47′ 0″	84° 57′ 24″	25° 58′ 39″
Head of Serpentarius.	6h 5m 58s	18° 5′ 22″	32′ 28″	232° 1′ 58″	259° 47′ 52″	27° 45′ 54″	43° 7′ 34″
Tail of Cygnus.	6h 14m 40s	18° 5′ 44″	32′ 50″	234° 12′ 50″	307° 29′ 45″	73° 16′ 55″	43° 19′ 42″
			February 7	Morning.			
Head of Serpentarius.	4h 44m 47s	19° 2′ 45″	♑ 29′ 2″	212° 40′ 47″	259° 47′ 52″	47° 7′ 5″	34° 35′ 0″
Tail of Cygnus.	4h 51m 35s	19° 3′ 2″	29′ 19″	214° 23′ 4″	307° 29′ 45″	93° 6′ 41″	32° 54′ 10″
Outermost [star] of the southern wing of Cygnus.	5h 16m 51s	19° 4′ 6″	30′ 22″	220° 43′ 7″	314° 47′ 0″	94° 3′ 53″	20° 55′ 23″
Right knee of Pegasus.	5h 24m 46s	19° 4′ 26″	0′ 42″	222° 42′ 12″	336° 47′ 50″	114° 5′ 38″	10° 17′ 30″
Bright Star of Lyra.	5h 42m 25s	19° 5′ 9″	31′ 24″	225° 5′ 39″	276° 21′ 43″	49° 16′ 4″	53° 29′ 20″
Head of Serpentarius.	5h 54m 25s	19° 5′ 39″	31′ 53″	230° 8′ 8″	259° 47′ 52″	29° 39′ 44″	42° 25′ 16″
Tail of Cygnus.	6h 0m 39s	19° 5′ 55″	32′ 9″	231° 41′ 54″	307° 29′ 45″	75° 47′ 51″	41° 57′ 50″

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In the year 1661.

Names of the fixed stars	Time before noon (h m s)	Place of the Sun	Right ascension of the Sun (° ′ ″)	Right ascension of the midheaven (° ′ ″)	Right ascension of the stars (° ′ ″)	Their distance from the meridian (° ′ ″)	Alti-tude (° ′ ″)
			February 10	Morning.			
Head of Serpentarius.	4h 39m 30s	22° 4′ 43″	327° 27′ 16″	214° 19′ 46″	259° 47′ 50″	45° 28′ 4″	35° 24′ 36″
Tail of Cygnus.	4h 48m 30s	22° 5′ 6″	27′ 38″	216° 35′ 8″	307° 29′ 45″	90° 54′ 37″	34° 0′ 20″
Outermost [star] of the southern wing of Cygnus.	4h 55m 45s	22° 5′ 2″	[Lu-cuna]″ 27′ 56″	218° 24′ 11″	314° 47′ 0″	96° 22′ 49″	19° 40′ 5″
Right knee of Pegasus.	5h 2m 12s	22° 5′ 47″	28′ 18″	220° 38′ 48″	336° 47′ 50″	116° 9′ 2″	9° 19′ 28″
Bright Star of Lyra.	5h 14m 40s	22° 6′ 0″	28′ 31″	224° 23′ 31″	276° 21′ 43″	51° 58′ 12″	51° 54′ 18″
Tail of Cygnus.	5h 28m 5s	22° 6′ 26″	28′ 56″	226° 56′ 26″	307° 29′ 45″	80° 33′ 19″	39° 23′ 3″
Head of Serpentarius.	5h 36m 17s	22° 6′ 42″	29′ 12″	228° 33′ 27″	259° 47′ 52″	31° 14′ 25″	41° 48′ 38″
Lower [star] in the right hand of Serpentarius.	5h 45m 30s	22° 7′ 30″	29′ 34″	230° 52′ 4″	265° 9′ 1″	34° 16′ 57″	19° 46′ 39″
Head of Serpentarius.	5h 55m 35s	22° 7′ 46″	29′ 58″	233° 23′ 43″	259° 47′ 52″	26° 24′ 9″	43° 36′ 40″
Tail of Cygnus.	6h 1m 55s		30′ 14″	234° 58′ 59″	307° 29′ 45″	72° 30′ 46″	43° 45′ 6″
			February 13	Morning.			
Tail of Cygnus.	4h 26m 30s	25° 6′ 6″	327° 23′ 34″	214° 1′ 4″	307° 29′ 45″	93° 27′ 41″	32° 43′ 50″

635 Arrangement of the second table. The page sets each quantity in separate columns of degrees, minutes and seconds (hours, minutes and seconds for the time), joined here into one cell per quantity; the rule groups are not reproduced. Each day opens with a line in roman giving the date in the column of the Sun's right ascension and the word for morning in the column of the midheaven. In the first row of each day the page prints the sign after the Sun's place and the degrees of the Sun's right ascension; in the other rows of the day it prints neither, and the cells are given here as they stand, with minutes and seconds only. In the fifth row of February 5 no place of the Sun is printed. Names too long for their cell are completed on the page in the cell below or above, and are given here whole. The date of February 5 is printed Februariii. The values are printed as they stand and have not been recomputed. Every time in the second column is the corrected time of an observation of the same star on the same day in the observation tables of the preceding pages. The distance from the meridian is the right ascension of the star less that of the midheaven in every row but one: for the Bright Star of Lyra on February 7, 276° 21′ 43″ less 225° 5′ 39″ gives 51° 16′ 4″, not the printed 49° 16′ 4″, and the midheaven expected from the neighbouring rows is near 227°. In the second row of February 6 the place of the Sun, its right ascension and the midheaven advance from the row before as for under 3 minutes of time, not the 12 minutes 44 seconds between the printed times, and the next row makes up the difference. On February 5 the Sun's place advances only 29″ between the fourth and sixth rows, about half its usual rate.

Names of the fixed stars	Time before noon (h m s)	Place of the Sun	Right ascension of the Sun (° ′ ″)	Right ascension of the midheaven (° ′ ″)	Right ascension of the stars (° ′ ″)	Their distance from the meridian (° ′ ″)	Alti-tude (° ′ ″)
	$4^h\ 32^m\ 30^s$	25° 6′ 21″	23′ 48″	215° 31′ 18″	307° 29′ 45″	91° 58′ 27″	33° 28′ 14″
In the elbow of the southern wing of Cygnus.	$4^h\ 49^m\ 50^s$	25° 7′ 5″	24′ 40″	219° 52′ 10″	308° 7′ 50″	88° 15′ 40″	27° 1′ 31″
In the elbow of the northern wing of Cygnus.	$5^h\ 7^m\ 40^s$	25° 7′ 50″	25′ 23″	224° 20′ 23″	293° 39′ 55″	69° 19′ 32″	45° 40′ 42″
In the elbow of the southern wing of Cygnus.	$5^h\ 34^m\ 0^s$	25° 8′ 56″	26′ 27″	230° 56′ 27″	308° 7′ 50″	77° 11′ 23″	33° 14′ 20″
In the elbow of the northern wing of Cygnus.	$5^h\ 49^m\ 20^s$	25° 9′ 35″	27′ 5″	234° 47′ 5″	293° 39′ 55″	58° 52′ 50″	51° 35′ 33″
			February 20	Morning.			
In the elbow of the southern wing of Cygnus.	$4^h\ 49^m\ 20^s$	2° 10′ 22″	34′ 10″ 15″	226° 30′ 15″	308° 7′ 50″	81° 37′ 35″	30° 43′ 11″
	$4^h\ 53^m\ 20^s$	2° 10′ 32″	0′ 24″	227° 30′ 24″	308° 7′ 50″	80° 37′ 26″	31° 17′ 10″
In the elbow of the northern wing of Cygnus.	$5^h\ 0^m\ 20^s$	2° 10′ 50″	0′ 41″	229° 15′ 41″	293° 39′ 55″	64° 24′ 14″	48° 26′ 35″
	$5^h\ 2^m\ 0^s$	2° 10′ 54″	0′ 45″	229° 40′ 45″	293° 39′ 55″	63° 59′ 10″	48° 40′ 43″
Tail of Cygnus.	$5^h\ 7^m\ 0^s$	2° 11′ 7″	10′ 57″	230° 55′ 57″	307° 29′ 45″	76° 33′ 48″	41° 31′ 58″
			March 2	Morning.			
Outermost [star] of the southern wing of Cygnus.	$3^h\ 52^m\ 0^s$	12° 10′ 13″	34′ 34″ 0″	221° 34′ 0″	314° 47′ 0″	93° 13′ 0″	21° 23′ 0″
Tail of Cygnus.	$4^h\ 3^m\ 0^s$	12° 10′ 48″	34′ 26″	224° 19′ 26″	307° 29′ 45″	83° 10′ 19″	38° 0′ 30″
In the elbow of the northern wing of Cygnus.	$4^h\ 10^m\ 42^s$	12° 11′ 0″	34′ 44″	226° 15′ 14″	293° 39′ 55″	67° 24′ 41″	46° 44′ 54″
Bright Star of Lyra.	$4^h\ 27^m\ 0^s$	12° 11′ 41″	35′ 22″	230° 20′ 22″	276° 21′ 43″	46° 1′ 21″	43° 7′ 42″
Tail of Cygnus.	$4^h\ 41^m\ 0^s$	12° 12′ 16″	35′ 55″	233° 50′ 55″	307° 29′ 45″	73° 38′ 50″	55° 21′ 3″
Outermost [star] of the southern wing of Cygnus.	$4^h\ 51^m\ 0^s$	12° 12′ 43″	36′ 18″	236° 21′ 18″	314° 47′ 0″	78° 25′ 42″	29° 42′ 4″
			March 10	Morning.			
In the elbow of the northern wing of Cygnus.	$2^h\ 52^m\ 0^s$	20° 7′ 2″	56′ 55″ 19″	213° 55′ 19″	293° 39′ 55″	79° 44′ 36″	39° 59′ 3″
Tail of Cygnus.	$3^h\ 1^m\ 0^s$	20° 7′ 24″	55′ 39″	216° 10′ 39″	307° 29′ 45″	91° 19′ 6″	33° 47′ 59″
Outermost [star] of the southern wing of Cygnus.	$3^h\ 17^m\ 0^s$	20° 8′ 4″	56′ 16″	220° 11′ 16″	314° 47′ 0″	94° 35′ 44″	20° 37′ 57″
Bright Star of Lyra.	$3^h\ 30^m\ 0^s$	20° 8′ 36″	56′ 45″	223° 26′ 45″	276° 21′ 43″	52° 54′ 58″	51° 21′ 20″
Tail of Cygnus.	$3^h\ 36^m\ 0^s$	20° 8′ 51″	56′ 59″	224° 56′ 59″	307° 29′ 45″	82° 32′ 46″	38° 12′ 53″

Names of the fixed stars	Time before noon (h m s)	Place of the Sun	Right ascension of the Sun (° ′ ″)	Right ascension of the midheaven (° ′ ″)	Right ascension of the stars (° ′ ″)	Their distance from the meridian (° ′ ″)	Alti-tude (° ′ ″)

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[Margin: Tab. B Locum 'Com. viſum exhibet.] *Table B gives the apparent place of the comet.*

In order, then, Table A comes first; Table B follows it, giving the apparent place of the comet (that is, not yet freed at all from the refractions) with respect both to the ecliptic and to the equator. By what route this was done for this comet we have deliberately left out here, since it has been shown sufficiently both in Book 1 and in the *descript. Com.* 1665.

[Margin: Tab.C locum á refractione depurgatum.] *Table C: the place purged of refraction.*

Table C gives the true place of the comet, wholly exempt from refraction, in the same order as the preceding Table B.

[Margin: Tab. D & E motum proprium, Angul. Orb. & Nodũ.] *Tables D and E: the proper motion, the angle of the orbit and the node.*

Table D: the proper motion of the comet, the angle of the orbit and the ecliptic, and the node. Table E: the proper motion of the comet from the right ascensions and declinations, and no less the angle of the orbit and the equator, with the place of their intersection.

[636] Arrangement of the table. It continues the table of the preceding page, under its own heading, in the same arrangement: the quantities set on the page in separate columns of degrees, minutes and seconds (hours, minutes and seconds for the time) are joined here into one cell each, and the rule groups are not reproduced. Each day opens with a line giving the date and the word for morning. In each day's first row the page prints the sign after the Sun's place and the degrees of the Sun's right ascension; in the other rows it prints neither. In the last row of February 10 no place of the Sun is printed, and in the second row of February 13 no star is named. Names too long for their cell are completed on the page in the cell below or above and are given here whole; in the third row of March 10 the name is misprinted, with a wrong letter for the C of Cygni. In the third row of February 10 the seconds of the Sun's place stand at a hole in the leaf, of which only the first figure, 2, survives. In the last row of February 13 the first figure of the seconds of the distance from the meridian is imperfectly printed and is read as 5. The values are printed as they stand and have not been recomputed. Every time in the second column is the corrected time of an observation of the same star on the same day in the observation tables. The distance from the meridian is the right ascension of the star less that of the midheaven in every row but the first of February 13, where the subtraction gives 93° 28′ 41″, not the printed 93° 27′ 41″. In the first row of February 10 the right ascension of the Head of Serpentarius is printed 259° 47′ 50″, against 259° 47′ 52″ in the other rows. On March 2 the altitude of the Tail of Cygnus at $4^{h}\ 41^{m}$, printed 55° 21′ 3″, stands well above the altitudes of that star on the same morning in this table (38° 0′ 30″ at $4^{h}\ 3^{m}$) and in the observation table (41° 12′ 0″ at $4^{h}\ 27^{m}$ and 45° 32′ 0″ at $4^{h}\ 58^{m}\ 22^{s}$).

[Margin: Tab. F, motum diurnum & horarium.] *Table F: the daily and hourly motion.*

Table F: the daily motion, both continuous and hourly, for each day of observation.

[Margin: Tab. G variationem ang. inclin.] *Table G: the variation of the angle of inclination.*

Table G: the variation of the angle of the orbit and the ecliptic, and also of the equa- [Margin: Tab. H motum Longit. Latit. &c. exhibet.] *Table H gives the motion in longitude, latitude, etc.*

tor, and also of the point of intersection, likewise for each day. Table H, for its part: the motion in longitude, latitude, declination and right ascension, both daily and hourly, for any day from the first day of observation, that is, February 3, up to March 28. All of these were computed by me alone, so that I might be the more certain.

Table A.

Year 1665 [recte: 1661]. Month, day	Corrected time, morning (h m s)	Distance of the comet observed from the fixed stars (° ′ ″)	Altitudes of the fixed stars and of the comet (° ′)	Refraction of the comet (′ ″)	Distance sought, freed of refraction (° ′ ″)
February 3	$5^h\ 41^m\ 18^s$	from the Tail of Cygnus: 40° 30′ 0″	* 37° 13′; comet 7° 30′	7′ 30″	40° 35′ 55″
	$5^h\ 52^m\ 18^s$	from the Head of Serpentarius: 47° 12′ 40″	* 40° 36′; comet 8° 30′	6′ 23″	47° 17′ 34″
	$5^h\ 58^m\ 32^s$	from the second-to-last [star] of the Tail of Serpens: 36° 15′ 30″	* 22° 15′; comet 9° 15′	6′ 0″	36° 18′ 27″
	$6^h\ 19^m\ 59^s$	from the Tail of Cygnus: 40° 31′ 25″	* 42° 24′; comet 11° 45′	4′ 30″	40° 34′ 0″
February 5	$4^h\ 58^m\ 49^s$	from the Head of Serpentarius: 44° 12′ 45″	* 35° 21′; comet 3° 30′	12′ 0″	44° 21′ 18″
	$5^h\ 1^m\ 57^s$	from the Head of Serpentarius: 44° 12′ 25″	* 35° 20′; comet 3° 30′	12′ 0″	44° 20′ 48″
	$5^h\ 14^m\ 13^s$	from the Tail of Cygnus: 39° 34′ 55″	* 34° 45′; comet 6° 0′	9′ 0″	39° 42′ 5″
	$5^h\ 17^m\ 1^s$	from the Tail of Cygnus: 39° 33′ 25″	* 34° 45′; comet 6° 0′	9′ 0″	39° 40′ 27″
	$5^h\ 26^m\ 52^s$	Outermost [star] of the southern wing of Cygnus: 26° 16′ 45″	* 21° 12′; comet 8° 0′	6′ 45″	26° 20′ 15″
	$5^h\ 36^m\ 42^s$	from the second-to-last [star] of the Tail of Serpens: 33° 40′ 15″	* 20° 43′; comet 9° 30′	5′ 45″	33° 42′ 43″
	$5^h\ 45^m\ 58^s$	from the Head of Serpentarius: 44° 13′ 0″	* 40° 47′; comet 11° 0′	5′ 0″	44° 16′ 38″
	$5^h\ 57^m\ 33^s$	from the Tail of Cygnus: 39° 40′ 45″	* 40° 27′; comet 13° 0′	4′ 0″	39° 43′ 15″
February 6	$5^h\ 6^m\ 48^s$	from the second-to-last [star] of the Tail of Serpens: 32° 19′ 55″	* 17° 37′; comet 6° 0′	9′ 0″	32° 23′ 37″

Year 1665 [recte: 1661]. Month, day	Corrected time, morning (h m s)	Distance of the comet observed from the fixed stars (° ′ ″)	Altitudes of the fixed stars and of the comet (° ′)	Refraction of the comet (′ ″)	Distance sought, freed of refraction (° ′ ″)
	$5^h\ 19^m\ 32^s$	from the Head of Serpentarius: 42° 37′ 45″	* 37° 8′; comet 9° 0′	6′ 0″	42° 40′ 25″
	$5^h\ 31^m\ 59^s$	from the Tail of Cygnus: 39° 22′ 30″	* 37° 34′; comet 10° 30′	5′ 15″	39° 26′ 25″
	$5^h\ 57^m\ 10^s$	from the outermost [star] of the wing of Cygnus: 26° 38′ 15″	* 25° 59′; comet 15° 0′	3′ 0″	26° 40′ 0″
	$6^h\ 5^m\ 58^s$	from the Head of Serpentarius: 42° 38′ 50″	* 43° 8′; comet 16° 0′	2′ 30″	42° 40′ 42″
	$6^h\ 14^m\ 40^s$	from the Tail of Cygnus: 39° 27′ 15″	* 43° 20′; comet 17° 0′	2′ 0″	39° 28′ 40″

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Table A.

Year 1661. Month, day	Corrected time, morning (h m s)	Distance of the comet observed from the fixed stars (° ′ ″)	Altitudes of the fixed stars and of the comet (° ′)	Refraction of the comet (′ ″)	Distance sought, freed of refraction (° ′ ″)
February 7	$4^h\ 44^m\ 47^s$	from the Head of Serpentarius: 41° 15′ 15″	* 34° 35′; comet 6° 0′	9′ 0″	41° 21′ 55″
	$4^h\ 51^m\ 35^s$	from the Tail of Cygnus: 39° 8′ 55″	* 32° 54′; comet 7° 0′	8′ 0″	39° 14′ 37″
	$5^h\ 16^m\ 51^s$	from the outermost [star] of the wing of Cygnus: 26° 50′ 20″	* 20° 55′; comet 11° 0′	5′ 0″	26° 52′ 30″
	$5^h\ 24^m\ 52^s$	from the right knee of Pegasus: 41° 4′ 30″	* 10° 17′; comet 12° 0′	star 5′ 0″; comet 4′ 30″	41° 4′ 45″

637 Arrangement of Table A. The page sets each observation on two or three lines: the time, the star from which the distance was taken and the star's altitude on the first line; the distance, the comet's altitude, the refraction and the freed distance on the last; here each observation is one row, and the figures set in separate columns of degrees, minutes and seconds (hours, minutes and seconds for the time) are joined into one cell. In the altitude column the page marks the star's altitude with an asterisk, as given here, and the comet's with Com. The altitudes are printed in degrees and minutes only. The date is printed only in the first row of each day. In the ninth row the star is named without the word from. The heading of the first column prints the year 1665, where the dates and times are those of the 1661 tables of the preceding pages; the heading of the refraction column prints Cometa where the other headings print the genitive. The values are printed as they stand and have not been recomputed. Every time is the time of an observation of the same star on the same day in the table on the page before last, except $5^h\ 1^m\ 57^s$ and $5^h\ 17^m\ 1^s$ of February 5, which have no row there; that table's row for the Head of Serpentarius at $6^h\ 21^m\ 6^s$ on February 5 has none here. The star altitudes are that table's altitudes to the nearest minute, the second and fourth rows of February 5 repeating the altitude of the row before.

Year 1661. Month, day	Corrected time, morning (h m s)	Distance of the comet observed from the fixed stars (° ′ ″)	Altitudes of the fixed stars and of the comet (° ′)	Refraction of the comet (′ ″)	Distance sought, freed of refraction (° ′ ″)
	$5^h\ 42^m\ 25^s$	from the Bright Star of Lyra: 39° 57′ 50″	* 53° 29′; comet 14° 30′	3′ 0″	40° 1′ 40″
	$6^h\ 0^m\ 39^s$	from the Tail of Cygnus: 39° 11′ 0″	* 41° 58′; comet 17° 0′	2′ 0″	39° 11′ 22″
February 10	$4^h\ 39^m\ 30^s$	from the Head of Serpentarius: 37° 23′ 45″	* 35° 25′; comet 9° 0′	6′ 0″	37° 28′ 15″
	$4^h\ 48^m\ 30^s$	from the Tail of Cygnus: 39° 5′ 30″	* 34° 0′; comet 11° 0′	5′ 0″	39° 8′ 50″
	$4^h\ 55^m\ 45^s$	from the outermost [star] of the wing of Cygnus: 28° 7′ 15″	* 19° 40′; comet 12° 0′	4′ 30″	28° 8′ 30″
	$5^h\ 2^m\ 12^s$	from the right knee of Pegasus: 43° 33′ 30″	* 9° 19′; comet 13° 0′	star 6′ 0″; comet 4′ 0″	43° 33′ 30″
	$5^h\ 14^m\ 40^s$	from the Bright Star of Lyra [printed Lui., recte: Luc.]: 37° 40′ 20″	* 51° 54′; comet 15° 0′	3′ 0″	37° 43′ 32″
	$5^h\ 28^m\ 5^s$	from the Tail of Cygnus: 39° 7′ 45″	* 39° 23′; comet 16° 0′	2′ 30″	39° 9′ 22″
	$5^h\ 36^m\ 17^s$, doubtful	from the Head of Serpentarius: 37° 31′ 35″	* 41° 49′; comet 17° 0′	2′ 0″	37° 33′ 2″
	$5^h\ 45^m\ 30^s$	from the lower [star] in the right hand of Serpentarius: 35° 39′ 5″	* 19° 47′; comet 18° 0′	1′ 15″	35° 39′ 10″
February 13	$4^h\ 32^m\ 30^s$	from the Tail of Cygnus: 39° 28′ 45″	* 33° 28′; comet 14° 0′	3′ 30″	39° 30′ 32″
	$4^h\ 49^m\ 50^s$	from the elbow of the lower wing of Cygnus: 29° 17′ 0″	* 27° 2′; comet 14° 30′	3′ 15″	29° 18′ 43″
	$5^h\ 7^m\ 40^s$	from the elbow of the upper wing of Cygnus: 38° 5′ 30″	* 45° 41′; comet 17° 0′	2′ 0″	38° 7′ 0″
March 10	$2^h\ 52^m\ 0^s$	from the elbow of the northern wing of Cygnus: 40° 34′ 20″	* 39° 59′; comet 15° 0′	3′ 0″	40° 36′ 35″
	$3^h\ 1^m\ 0^s$	from the Tail of Cygnus: 44° 19′ 0″	* 33° 48′; comet 17° 0′	2′ 0″	44° 20′ 4″
	$3^h\ 17^m\ 0^s$	from the outermost [star] of the wing of Cygnus: 37° 22′ 40″	* 20° 38′; comet 19° 0′	1′ 30″	37° 22′ 38″

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Table B.
Showing the apparent place of the comet, with respect both to the ecliptic and to the equator.

Year 1661. Month, day	Corrected time, morning (h m s)	Distances of the comet, both observed from the fixed stars and derived by calculation, for finding the apparent place of the comet (° ′ ″)	Apparent longitude of the comet (° ′ ″, sign)	Apparent northern latitude of the comet (° ′ ″)	Northern declination (° ′ ″)	Right ascension (° ′ ″)
February 3	$5^h\ 47^m\ 0^s$	the comet from the Tail of Cygnus: 40° 30′ 0″; from the Head of Serpentarius: 47° 12′ 40″; Tail of Cygnus from the Head of Serpentarius: 51° 12′ 50″	♑ 10° 1′ 48″ ≈	22° 8′ 11″ B.	3° 35′ 36″	306° 39′ 10″
	$5^h\ 58^m\ 32^s$	comet from the last [star] of the Tail of Serpens: 36° 15′ 30″; from the Head of Serpentarius: 47° 12′ 40″; last [star] of the Tail of Serpens from the Head of Serpentarius: 19° 17′ 6″	10° 4′ 41″ ≈	22° 12′ 45″ B.	3° 40′ 43″	306° 40′ 14″
	$6^h\ 19^m\ 59^s$	comet from the Tail of Cygnus: 40° 31′ 25″; from the Head of Serpentarius: 47° 12′ 40″	♑ 10° 1′ 13″ ≈	22° 7′ 16″ B.	3° 34′ 37″	306° 38′ 54″
February 5	$5^h\ 6^m\ 0^s$	comet from the Tail of Cygnus: 39° 34′ 55″; from the Head of Serpentarius: 44° 12′ 45″	♑ 7° 20′ 38″ ≈	23° 51′ 55″ B.	4° 38′ 55″	303° 49′ 0″
	$5^h\ 9^m\ 0^s$	comet from the Tail of Cygnus: 39° 33′ 25″; from the Head of Serpentarius: 44° 12′ 25″	♑ 7° 20′ 6″ ≈	23° 51′ 25″ B.	4° 38′ 23″	303° 48′ 49″
	$5^h\ 30^m\ 0^s$	comet from the Tail of Cygnus: 39° 34′ 55″; from the second-to-last [star] of the Tail of Serpens: 33° 40′ 15″; distance of the stars: 57° 12′ 40″	7° 22′ 3″ ≈	23° 52′ 18″ B.	4° 39′ 21″	303° 48′ 33″

[638] Arrangement of Table A, continued. The table continues that of the preceding page under the same title and its own heading, in the same arrangement: each observation, set on the page on two or three lines, is one row here, and the figures set in separate columns of degrees, minutes and seconds (hours, minutes and seconds for the time) are joined into one cell. Here the year is printed 1661. The unit line over the altitudes prints minutes and seconds, but the figures beneath are degrees and minutes, as on the preceding page. In the two rows taken from the right knee of Pegasus, a star standing low, the page prints a refraction for the star as well as for the comet. In one row of February 10 the time carries the word doubtful (dub.); in another the name of the Bright Star of Lyra is misprinted Lui.; in the row from the lower star in the right hand the word for hand is misprinted mannu. The wing star of February 13 at $4^h\ 49^m$ is named the elbow of the lower wing and that of $5^h\ 7^m$ the elbow of the upper wing, where the table of the page before last names them the southern and the northern wing; the star of March 10 at $2^h\ 52^m$ is named with B. (northern). The values are printed as they stand and have not been recomputed. The times are those of the observations of the same stars on the same mornings in the tables of pp. 851–852, except that for the right knee of Pegasus on February 7 this table prints $5^h\ 24^m\ 52^s$ and the table of p. 851 prints $5^h\ 24^m\ 46^s$. The freed distance exceeds the observed in every row but two: from the right knee of Pegasus on February 10 the two are equal, and from the outermost star of the wing of Cygnus on March 10 the freed distance is 2″ less than the observed.

Year 1661. Month, day	Corrected time, morning (h m s)	Distances of the comet, both observed from the fixed stars and derived by calculation, for finding the apparent place of the comet (° ′ ″)	Apparent longitude of the comet (° ′ ″, sign)	Apparent northern latitude of the comet (° ′ ″)	Northern declination (° ′ ″)	Right ascension (° ′ ″)
	$5^h\ 40^m\ 0^s$	comet from the Head of Serpentarius: 44° 13′ 0″; from the last [star] of the Tail of Serpens: 33° 40′ 15″	7° 22′ 7″ ≈	23° 54′ 35″ B.	4° 44′ 6″	303° 48′ 10″
	$5^h\ 47^m\ 0^s$	comet from the Tail of Cygnus: 39° 40′ 45″; from the second-to-last [star] of the Tail of Serpens: 33° 40′ 15″	7° 22′ 6″ ≈	23° 47′ 5″ B.	4° 34′ 10″	303° 47′ 31″
February 6	$5^h\ 25^m\ 0^s$	comet from the Tail of Cygnus: 39° 22′ 30″; from the Head of Serpentarius: 42° 37′ 45″	* 5° 47′ 43″ ≈	24° 35′ 0″ B.	5° 0′ 35″	302° 16′ 14″
	$5^h\ 38^m\ 0^s$	comet from the outermost [star] of the wing of Cygnus: 26° 38′ 15″; from the Head of Serpentarius: 42° 37′ 45″	* 5° 48′ 1″ ≈	24° 35′ 39″ B.	5° 1′ 19″	302° 16′ 17″
	$6^h\ 10^m\ 0^s$	comet from the Tail of Cygnus: 39° 17′ 15″; from the Head of Serpentarius: 42° 38′ 50″	* 5° 51′ 6″ ≈	24° 38′ 28″ B.	5° 4′ 35″	302° 18′ 24″
February 7	$4^h\ 48^m\ 0^s$	comet from the Tail of Cygnus: 39° 8′ 55″; from the Head of Serpentarius: 41° 15′ 15″	* 4° 28′ 56″ ≈	25° 16′ 43″ B.	5° 24′ 45″	300° 56′ 47″
	$5^h\ 8^m\ 0^s$	comet from the outermost [star] of the wing of Cygnus: 26° 50′ 20″; from the Head of Serpentarius: 41° 15′ 15″	* 4° 29′ 18″ ≈	25° 17′ 0″ B.	5° 25′ 5″	300° 57′ 0″
	$5^h\ 17^m\ 0^s$	comet from the Bright Star of Lyra: 39° 57′ 50″; from the Tail of Cygnus: 39° 8′ 55″; Bright Star of Lyra and Tail of Cygnus: 23° 52′ 45″	4° 32′ 36″ ≈	25° 13′ 44″ B.	5° 22′ 35″	301° 0′ 42″
	$5^h\ 27^m\ 0^s$	comet from the Bright Star of Lyra: 39° 57′ 50″; from the outermost [star] of the wing of Cygnus: 26° 50′ 20″; distance of the stars: 33° 1′ 10″	4° 30′ 37″ ≈	25° 13′ 51″ B.	5° 22′ 13″	300° 58′ 44″
	$5^h\ 34^m\ 0^s$	comet from the Bright Star of Lyra: 39° 57′ 50″; from the right knee of Pegasus: 41° 4′ 30″; Lyra from the right knee of Pegasus: 50° 28′ 50″	4° 27′ 57″ ≈	25° 14′ 0″ B.	5° 22′ 8″	300° 56′ 31″
	$5^h\ 52^m\ 0^s$	comet from the Bright Star of Lyra: 39° 57′ 50″; from the Tail of Cygnus: 39° 11′ 0″	4° 29′ 36″ ≈	25° 12′ 55″ B.	5° 21′ 8″	300° 58′ 15″
February 10	$4^h\ 44^m\ 0^s$	comet from the Tail of Cygnus: 39° 5′ 30″; from the Head of Serpentarius: 37° 23′ 45″	0° 30′ 10″ ≈	26° 44′ 24″ B.	6° 4′ 26″	297° 7′ 16″
	$4^h\ 52^m\ 0^s$	comet from the Tail of Cygnus: 39° 5′ 30″; from the outermost [star] of the wing of Cygnus: 28° 7′ 15″	doubtful; 0° 38′ 44″ ≈	26° 45′ 8″ B.	6° 6′ 25″	297° 14′ 33″
	$4^h\ 55^m\ 0^s$	comet from the Tail of Cygnus: 39° 5′ 30″; from the right knee of Pegasus: 43° 33′ 30″; Tail of Cygnus from the right knee of Pegasus: 28° 7′ 5″	0° 40′ 1″ ≈	26° 43′ 20″ B.	6° 5′ 5″	297° 16′ 2″

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Table B.

Year 1661. Month, day	Corrected time, morning (h m s)	Distances of the comet, both observed from the fixed stars and derived by calculation, for finding the apparent place of the comet (° ′ ″)	Apparent longitude of the comet (° ′ ″, sign)	Apparent northern latitude of the comet (° ′ ″)	Northern declination (° ′ ″)	Right ascension (° ′ ″)
	$5^h\ 5^m\ 0^s$	comet from the Bright Star of Lyra: 37° 40′ 20″; from the Tail of Cygnus: 39° 5′ 30″	0° 50′ 41″ ♒	26° 37′ 58″ B.	6° 1′ 41″	297° 26′ [?]
	$5^h\ 5^m\ 0^s$	comet from the Bright Star of Lyra: 37° 39′ 30″; from the Tail of Cygnus: 39° 5′ 30″	0° 49′ 20″ ♒	26° 38′ 29″ B.	6° 2′ 0″	297° 25′ [?]
	$5^h\ 5^m\ 0^s$	comet from the Bright Star of Lyra: 37° 39′ 30″; from the outermost [star] of the wing of Cygnus: 28° 7′ 15″	* 0° 44′ 48″ ♒	26° 39′ 42″ B.	6° 2′ 3″	297° 21′ [?]
	$5^h\ 5^m\ 0^s$	comet from the Bright Star of Lyra: 37° 40′ 20″; from the outermost [star] of the wing of Cygnus: 28° 7′ 15″	* 0° 44′ 27″ ♒	26° 39′ 58″ B.	6° 2′ 29″	297° 20′ [?]
	$5^h\ 15^m\ 0^s$	comet from the Tail of Cygnus: 39° 7′ 45″; from the right knee of Pegasus: 43° 33′ 30″	0° 41′ 49″ ♒	26° 39′ 58″ B.	6° 2′ 0″	297° 18′ [?]
February 13	$4^h\ 36^m\ 0^s$	comet from the elbow of the upper wing of Cygnus: 38° 5′ 30″; from the Tail of Cygnus: 39° 28′ 45″; distance of the stars: 9° 53′ 48″	27° 49′ 2″ ♑	27° 26′ 28″ B.	6° 17′ 11″	294° 38′ [?]
	$4^h\ 58^m\ 0^s$	comet from the elbow of the upper wing: 38° 5′ 30″; from the elbow of the lower wing of Cygnus: 29° 17′ 0″; distance of the stars: 16° 11′ 7″	* 27° 47′ 29″ ♑	27° 26′ 13″ B.	6° 16′ 55″	294° 36′ [?]

639 Arrangement of Table B. The page sets each observation on two or three lines: the time on the first line, each distance on its own line beside the name of the star or stars it was taken from, and the longitude, latitude, declination and right ascension once, in the middle of the row; here each observation is one row, the distances of a row are given in one cell in the order printed, and the figures set in separate columns of degrees, minutes and seconds (hours, minutes and seconds for the time) are joined into one cell. Where the third line of a row names two stars, or reads distance of the stars, its figure is the distance between the two stars, not a distance of the comet. The date is printed only in the first row of each day. An asterisk is printed above the longitude in nine rows and is given before the longitude here; the word doubtful (dub.) stands above the longitude in one row of February 10. The sign of Aquarius stands after every longitude and B. (northern) after every latitude, as printed. The heading of the latitude column prints Cometa where the genitive is expected. The values are printed as they stand and have not been recomputed. The distances of the comet are the observed distances of Table A for the same stars on the same mornings, except the distance from the Tail of Cygnus at $6^h\ 10^m$ on February 6, 39° 17′ 15″, where Table A has 39° 27′ 15″; the star named the last of the Tail of Serpens in the second row of February 3 and the fourth row of February 5 is named the second-to-last in Table A for the same distance. Two times are those of Table A; the others are whole minutes falling between the two observations combined in the row. The rows of February 10 run on beyond this page.

Year 1661. Month, day	Corrected time, morning (h m s)	Distances of the comet, both observed from the fixed stars and derived by calculation, for finding the apparent place of the comet (° ′ ″)	Apparent longitude of the comet (° ′ ″, sign)	Apparent northern latitude of the comet (° ′ ″)	Northern declination (° ′ ″)	Right ascension (° ′ ″)
	$5^h\ 32^m\ 0^s$	comet from the elbow of the upper wing: 38° 6′ 30″; from the elbow of the lower wing of Cygnus: 29° 18′ 0″	27° 47′ 25″ ♍	27° 26′ 39″ B.	6° 17′ 10″	294° 36′ [?]
February 14		doubtful	27° 5′ 43″ ♍	27° 40′ 24″ B.	6° 23′ 55″	293° 56′ 4[?]″
February 17		doubtful	26° 6′ 22″ ♍	28° 54′ 50″ B.	7° 27′ 49″	292° 51′ 3[?]″
February 20	$4^h\ 55^m\ 0^s$	comet from the elbow of the upper wing: 38° 11′ 25″; from the elbow of the lower wing of Cygnus: 31° 8′ 0″	* 23° 13′ 48″ ♍	28° 8′ 1″ B.	6° 16′ 14″	290° 28′ [?]
	$4^h\ 55^m\ 0^s$	comet from the elbow of the upper wing: 38° 10′ 30″; from the elbow of the lower wing of Cygnus: 31° 8′ 0″	23° 11′ 57″ ♍	28° 9′ 20″ B.	6° 15′ 23″	290° 27′ [?]
	$5^h\ 5^m\ 0^s$	comet from the elbow of the upper wing of Cygnus: 38° 11′ 25″; from the Tail of Cygnus: 40° 40′ 0″	* 23° 14′ 49″ ♍	28° 7′ 45″ B.	6° 16′ 5″	290° 29′ [?]
	$5^h\ 5^m\ 0^s$	comet from the elbow of the upper wing of Cygnus: 38° 10′ 30″; from the Tail of Cygnus: 40° 40′ 0″	doubtful; 23° 11′ 19″ ♍	28° 9′ 22″ B.	6° 17′ 12″	290° 26′ [?]
March 2	$3^h\ 58^m\ 0^s$	comet from the Tail of Cygnus: 42° 55′ 15″; from the outermost [star] of the wing of Cygnus: 35° 21′ 0″	* 19° 7′ 37″ ♍	27° 32′ 50″ B.	5° 9′ 51″	286° 57′ 3[?]″
	$4^h\ 2^m\ 0^s$	comet from the elbow of the upper wing of Cygnus: 39° 38′ 0″; from the outermost [star] of the southern wing of Cygnus: 35° 21′ 0″	* 19° 7′ 28″ ♍	27° 32′ 58″ B.	5° 10′ 2″	286° 57′ 2[?]″
	$4^h\ 10^m\ 0^s$	comet from the Bright Star of Lyra: 34° 41′ 5″; from the outermost [star] of the wing of Cygnus: 35° 21′ 0″	19° 6′ 16″ ♍	27° 34′ 27″ B.	5° 11′ 19″	286° 56′ 1[?]″
	$4^h\ 15^m\ 0^s$	comet from the Bright Star of Lyra: 34° 41′ 5″; from the Tail of Cygnus: 42° 55′ 15″	19° 5′ 30″ ♍	27° 33′ 54″ B.	5° 12′ 39″	286° 55′ 3[?]″
	$4^h\ 34^m\ 0^s$	comet from the Bright Star of Lyra: 34° 41′ 5″; from the Tail of Cygnus: 42° 55′ 45″	19° 4′ 32″ ♍	27° 33′ 48″ B.	5° 10′ 28″	286° 55′ 0″
March 10	$3^h\ 4^m\ 0^s$	comet from the elbow of the upper wing of Cygnus: 40° 36′ 35″; from the outermost [star] of the wing of Cygnus: 37° 22′ 40″	* 16° 34′ 16″ ♍	27° 10′ 6″ B.	4° 33′ 15″	284° 42′ 11″
	$3^h\ 4^m\ 0^s$	comet from the elbow of the upper wing of Cygnus: 40° 34′ 20″; from the outermost [star] of the wing of Cygnus: 37° 22′ 40″	16° 31′ 46″ ♍	27° 13′ 0″ B.	4° 36′ 32″	284° 39′ 5″
	$3^h\ 16^m\ 0^s$	comet from the Bright Star of Lyra: 34° 48′ 0″; from the Tail of Cygnus: 44° 20′ 0″	16° 33′ 44″ ♍	27° 12′ 49″ B.		

Year 1661. Month, day	Corrected time, morning (h m s)	Distances of the comet, both observed from the fixed stars and derived by calculation, for finding the apparent place of the comet (° ′ ″)	Apparent longitude of the comet (° ′ ″, sign)	Apparent northern latitude of the comet (° ′ ″)	Northern declination (° ′ ″)	Right ascension (° ′ ″)
	$3^h\ 16^m$	comet from the Bright Star of Lyra: 34° 48′ 0″; from the Tail of Cygnus: 44° 19′ 0″	16° 36′ 8″ ♍	27° 12′ 52″ B.	4° 33′ 31″	284° 46′ 6″
	$3^h\ 24^m\ 0^s$	comet from the Bright Star of Lyra: 34° 48′ 0″; from the outermost [star] of the wing of Cygnus: 37° 22′ 40″	* 16° 33′ 20″ ♍	27° 11′ 8″ B.	4° 31′ 36″	284° 44′ 7″
March 28	$2^h\ 0^m\ 0^s$	about	13° 0′ 0″ ♍	26° 10′ 0″	3° 11′ 17″	281° 39′ 58″

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Table C.
Showing the true place of the comet with respect to the ecliptic.

Year 1661. Month, day	Time corrected from the altitudes of the fixed stars (h m s)	Distances of the comet, both observed from the fixed stars and freed of refraction, and derived by calculation, for finding the true place of the comet (° ′ ″)	Longitude of the comet stripped of all refraction (° ′ ″, sign)	Latitude of the comet stripped of all refraction (° ′ ″)
February 3	$5^h\ 47^m\ 0^s$	the comet from the Tail of Cygnus: 40° 35′ 55″; from the Head of Serpentarius: 47° 17′ 34″; Head of Serpentarius from the Tail of Cygnus: 51° 12′ 50″	10° 4′ 33″ ♒	22° 2′ 42″ B.

[640] Arrangement as on the preceding page: each observation is one row, its distances given in one cell in the order printed, the figures of separate degree, minute and second columns joined into one cell; a third line naming the distance of the stars gives the distance between the two stars, not a distance of the comet. The first five rows carry no date and continue the observations of February 10 begun on the preceding page. The month is printed in each date cell. The sign of Aquarius stands after the longitude in the rows of February 10, the sign of Capricorn in every row from February 13 on; B. (northern) stands after every latitude except in the last row, where no letter is printed. Asterisks are printed above the longitude in nine rows and are given before it; the word doubtful (dub.) stands above the longitude in the fourth row of February 20, and on February 14 and 17 at the right of the distance column, where nothing else is printed in that column and no time is given. The row of $3^h\ 16^m\ 0^s$ on March 10 leaves the declination and right ascension empty; the next prints the time without seconds. On March 28 the word about (circ.) stands in the distance column in place of any distance. The seconds of the right ascension run into the gutter of the binding: they are legible whole in six rows and in their tens figure only in six, and not at all in twelve. Where a name reads elbow of the upper wing with no constellation named, the page prints none on that line. The values are printed as they stand and have not been recomputed.

Year 1661. Month, day	Time corrected from the altitudes of the fixed stars (h m s)	Distances of the comet, both observed from the fixed stars and freed of refraction, and derived by calculation, for finding the true place of the comet (° ′ ″)	Longitude of the comet stripped of all refraction (° ′ ″, sign)	Latitude of the comet stripped of all refraction (° ′ ″)
	$5^h\ 55^m\ 0^s$	the comet from the Head of Serpentarius: 47° 17′ 34″; from the second-to-last [star] of the Tail of Serpens: 36° 18′ 27″; Head of Serpentarius from the second-to-last [star] of the Tail of Serpens: 19° 17′ 6″	10° 7′ 26″ ≈	22° 7′ 31″ B.
	$6^h\ 19^m\ 59^s$	comet from the Tail of Cygnus: 40° 34′ 0″; from the Head of Serpentarius: 47° 17′ 34″; Tail of Cygnus from the Head of Serpentarius: 51° 12′ 50″	10° 5′ 11″ ≈	22° 2′ 54″ B.
February 5	$5^h\ 6^m\ 0^s$	comet from the Tail of Cygnus: 39° 42′ 5″; from the Head of Serpentarius: 44° 21′ 18″; Tail of Cygnus from the Head of Serpentarius: 51° 12′ 50″	7° 26′ 28″ ≈	23° 43′ 9″ B.
	$5^h\ 9^m\ 0^s$	comet from the Tail of Cygnus: 39° 40′ 27″; from the Head of Serpentarius: 44° 21′ 10″; Tail of Cygnus from the Head of Serpentarius: 51° 12′ 50″	7° 26′ 16″ ≈	23° 44′ 38″ B.
	$5^h\ 30^m\ 0^s$	comet from the Tail of Cygnus: 39° 42′ 5″; from the second-to-last [star] of the Tail of Serpens: 33° 42′ 43″; Tail of Cygnus from the second-to-last [star] of the Tail of Serpens: 57° 12′ 40″	7° 25′ 40″ ≈	23° 48′ 3″ B.
	$5^h\ 40^m\ 0^s$	comet from the Head of Serpentarius: 44° 16′ 38″; from the last [star] of the Tail of Serpens: 33° 42′ 43″; Head of Serpentarius from the last [star] of the Tail of Serpens: 19° 17′ 6″	7° 25′ 50″ ≈	23° 54′ 35″ B
	$5^h\ 47^m\ 0^s$	comet from the Tail of Cygnus: 39° 43′ 15″; from the second-to-last [star] of the Tail of Serpens: 33° 42′ 43″; Tail of Cygnus from the second-to-last [star] of the Tail of Serpens: 57° 12′ 40″	7° 25′ 42″ ≈	23° 47′ 0″ B.
February 6	$5^h\ 25^m\ 0^s$	the comet from the Tail of Cygnus: 39° 26′ 25″; from the Head of Serpentarius: 42° 40′ 25″	5° 47′ 26″ ≈	24° 28′ 36″ B.
	$5^h\ 38^m\ 0^s$	comet from the outermost [star] of the wing of Cygnus: 26° 40′ 0″; from the Head of Serpentarius: 42° 40′ 25″; outermost [star] of the wing of Cygnus from the Head of Serpentarius: 53° 14′ 17″	5° 50′ 18″ ≈	24° 33′ 51″ B.
	$5^h\ 45^m\ 0^s$	comet from the Tail of Cygnus: 39° 26′ 35″; from the outermost [star] of the wing of Cygnus: 26° 40′ 0″; Tail of Cygnus from the outermost [star] of the wing of Cygnus: 16° 16′ 20″	5° 46′ 8″ ≈	24° 30′ 53″ B.
	$6^h\ 10^m\ 0^s$	comet from the Tail of Cygnus: 39° 28′ 40″; from the Head of Serpentarius: 42° 40′ 42″	5° 47′ 26″ ≈	24° 28′ 30″ B.
February 7	$4^h\ 48^m\ 0^s$	the comet from the Tail of Cygnus: 39° 14′ 37″; from the Head of Serpentarius: 41° 21′ 55″	4° 29′ 46″ ≈	25° 3′ 12″ B.

Year 1661. Month, day	Time corrected from the altitudes of the fixed stars (h m s)	Distances of the comet, both observed from the fixed stars and freed of refraction, and derived by calculation, for finding the true place of the comet (° ′ ″)	Longitude of the comet stripped of all refraction (° ′ ″, sign)	Latitude of the comet stripped of all refraction (° ′ ″)
	$5^h\ 4^m\ 0^s$	comet from the Tail of Cygnus: 39° 14′ 37″; from the outermost [star] of the wing of Cygnus: 26° 52′ 30″	doubtful, because the triangle is too acute; 4° 35′ 54″ ♒	25° 5′ 36″ B.
	$5^h\ 8^m\ 0^s$	comet from the outermost [star] of the wing of Cygnus: 26° 52′ 30″; from the Head of Serpentarius: 41° 21′ 55″	4° 30′ 52″ ♒	25° 5′ 0″ B.
	$5^h\ 17^m\ 0^s$	comet from the Bright Star of Lyra: 40° 1′ 40″; from the Tail of Cygnus: 39° 14′ 37″; Bright Star of Lyra from the Tail of Cygnus: 23° 52′ 45″	4° 29′ 36″ ♒	25° 9′ 20″ B

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Table C.

Year 1661. Month, day	Time corrected from the altitudes of the fixed stars (h m s)	Distances of the comet, both observed from the fixed stars and freed of refraction, and derived by calculation, for finding the true place of the comet (° ′ ″)	Longitude of the comet stripped of all refraction (° ′ ″, sign)	Latitude of the comet stripped of all refraction (° ′ ″)
February 7	$5^h\ 27^m\ 0^s$	the comet from the Bright Star of Lyra: 40° 1′ 40″; from the outermost [star] of the wing of Cygnus: 26° 52′ 30″; Bright Star of Lyra and the outermost [star] of the wing of Cygnus: 33° 1′ 10″	4° 31′ 41″ ♒	25° 10′ 8″ B.

[641] Arrangement of Table C. The page sets each observation on two or three lines: the time on the first line, each distance on its own line beside the name of the star or stars it was taken from, and the longitude and latitude once, in the middle of the row; here each observation is one row, the distances of a row are given in one cell in the order printed, and the figures set in separate columns of degrees, minutes and seconds (hours, minutes and seconds for the time) are joined into one cell. Where the third line of a row names two stars, its figure is the distance between the two stars, not a distance of the comet. The date is printed only in the first row of each day. The table has no declination or right-ascension columns. The sign of Aquarius stands after every longitude and B. (northern) after every latitude, as printed; in two rows no point follows the B. In the second row of February 7 the words doubtful, because the triangle is too acute (dub. ob Triangul. nimis acutum.) run across the longitude and latitude columns above the figures; they are given in the longitude cell. The distances of the comet are the distances of Table A freed of refraction, except that from the Head of Serpentarius at $5^h\ 9^m$ on February 5 (44° 21′ 10″) and that from the Tail of Cygnus at $5^h\ 45^m$ on February 6 (39° 26′ 35″), which Table A does not give in that form. The times are those of Table B, except the second row of February 3, where Table B has $5^h\ 58^m\ 32^s$ for a different pair of stars, and the rows of $5^h\ 45^m$ on February 6 and $5^h\ 4^m$ on February 7, which have none in Table B. The values are printed as they stand and have not been recomputed.

Year 1661. Month, day	Time corrected from the altitudes of the fixed stars (h m s)	Distances of the comet, both observed from the fixed stars and freed of refraction, and derived by calculation, for finding the true place of the comet (° ′ ″)	Longitude of the comet stripped of all refraction (° ′ ″, sign)	Latitude of the comet stripped of all refraction (° ′ ″)
	$5^h\ 34^m\ 0^s$	the comet from the Bright Star of Lyra: 40° 1′ 40″; from the right knee of Pegasus: 41° 4′ 45″; Lyra from the right knee of Pegasus: 50° 28′ 50″	4° 29′ 25″ ♒	25° 10′ 30″ B.
	$5^h\ 52^m\ 0^s$	comet from the Bright Star of Lyra: 40° 1′ 40″; from the Tail of Cygnus: 39° 11′ 22″	4° 35′ 22″ ♒	25° 10′ 25″ B.
February 10	$4^h\ 44^m\ 0^s$	the comet from the Tail of Cygnus: 39° 8′ 50″; from the Head of Serpentarius: 37° 28′ 15″	0° 34′ 18″ ♒	26° 41′ 57″ B.
	$4^h\ 52^m\ 0^s$	comet from the Tail of Cygnus: 39° 8′ 50″; from the outermost [star] of the wing of Cygnus: 28° 8′ 30″	0° 43′ 35″ ♒	26° 37′ 21″ B.
	$4^h\ 55^m\ 0^s$	comet from the Tail of Cygnus: 39° 8′ 50″; from the right knee of Pegasus: 43° 33′ 30″; Tail of Cygnus from the right knee of Pegasus: 28° 7′ 5″	0° 43′ 27″ ♒	26° 37′ 56″ B.
	$5^h\ 8^m\ 0^s$	comet from the Bright Star of Lyra: 37° 43′ 32″; from the right knee of Pegasus: 43° 33′ 30″	0° 44′ 59″ ♒	26° 33′ 40″ B.
	$5^h\ 5^m\ 0^s$	comet from the Bright Star of Lyra: 37° 43′ 32″; from the Tail of Cygnus: 39° 8′ 50″	0° 50′ 11″ ♒	26° 34′ 30″ B.
	$5^h\ 5^m\ 0^s$	comet from the Bright Star of Lyra: 37° 42′ 10″; from the Tail of Cygnus: 39° 8′ 50″	0° 47′ 57″ ♒	26° 35′ 23″ B.
	$5^h\ 5^m\ 0^s$	comet from the Bright Star of Lyra: 37° 42′ 10″; from the outermost [star] of the wing of Cygnus: 28° 8′ 30″	0° 45′ 16″ ♒	26° 35′ 20″ B.
	$5^h\ 5^m\ 0^s$	comet from the Bright Star of Lyra: 37° 43′ 32″; from the outermost [star] of the wing of Cygnus: 28° 8′ 30″	0° 46′ 30″ ♒	26° 34′ 3″ B.
	$5^h\ 15^m\ 0^s$	comet from the Tail of Cygnus: 39° 9′ 22″; from the right knee of Pegasus: 43° 33′ 30″	0° 42′ 59″ ♒	26° 37′ 39″ B.
	$5^h\ 21^m\ 0^s$	comet from the Bright Star of Lyra: 37° 42′ 10″; from the Tail of Cygnus: 39° 9′ 22″	0° 47′ 3″ ♒	26° 35′ 12″ B.
	$5^h\ 21^m\ 0^s$	comet from the Bright Star of Lyra: 37° 43′ 32″; from the Tail of Cygnus: 39° 9′ 22″	0° 49′ 13″ ♒	26° 34′ 19″ B.
February 13	$4^h\ 36^m\ 0^s$	comet from the elbow *Serp.* [?] of the wing of Cygnus: 38° 7′ 0″; from the Tail of Cygnus: 39° 35′ 0″; Tail from the elbow of the upper wing of Cygnus: 9° 53′ 48″	27° 46′ 59″ ♑	27° 24′ 36″ B.
	$4^h\ 58^m\ 0^s$	comet from the elbow of the upper wing: 38° 7′ 0″; from the elbow of the lower wing of Cygnus: 29° 18′ 43″; distance of the stars: 16° 11′ 7″	27° 47′ 6″ ♑	27° 24′ 2″ B.
	$5^h\ 32^m\ 0^s$	comet from the elbow of the upper wing: 38° 6′ 30″; from the elbow of the lower wing of Cygnus: 29° 17′ 45″	27° 48′ 6″ ♑	27° 26′ 14″ B.

Year 1661. Month, day	Time corrected from the altitudes of the fixed stars (h m s)	Distances of the comet, both observed from the fixed stars and freed of refraction, and derived by calculation, for finding the true place of the comet (° ′ ″)	Longitude of the comet stripped of all refraction (° ′ ″, sign)	Latitude of the comet stripped of all refraction (° ′ ″)
March 10	$3^h\ 4^m\ 0^s$	comet from the elbow of the upper wing of Cygnus: 40° 36′ 35″; from the outermost [star] of the wing of Cygnus: 37° 22′ 40″; distance of the stars: 22° 45′ 25″	16° 34′ 16″ ♒	27° 10′ 6″ B.
	$3^h\ 4^m\ 0^s$	comet from the Tail of Cygnus: 44° 20′ 4″; from the outermost [star] of the wing of Cygnus: 37° 22′ 40″	16° 30′ 52″ ♒	27° 14′ 2″ B.
	$3^h\ 16^m\ 0^s$	comet from the Bright Star of Lyra: 34° 48′ 0″; from the Tail of Cygnus: 44° 20′ 4″	16° 33′ 44″ ♒	27° 12′ 49″ B.
	$3^h\ 24^m\ 0^s$	comet from the Bright Star of Lyra: 34° 48′ 0″; from the outermost [star] of the wing of Cygnus: 37° 22′ 40″	16° 33′ 20″ ♒	27° 11′ 8″ B.

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Table D.
Showing the proper motion, the angle of the orbit and the ecliptic, and also the node.

[642] Arrangement as on the preceding page: each observation is one row, its distances given in one cell in the order printed, and the figures of separate degree, minute and second columns (hour, minute and second for the time) joined into one cell; where the third line of a row names two stars, its figure is the distance between the two stars, not a distance of the comet. The date is printed only in the first row of each day; the observations of February 7 continue from the preceding page under a repeated date. The sign of Aquarius stands after every longitude through February 10, the sign of Capricorn after every longitude from February 13 on, and B. (northern) after every latitude. No longitude on this page is marked with an asterisk or as doubtful. In the first row of February 13 the page prints Serp. between elbow and wing, where the other rows of that day and the third line of the same row name the elbow of the upper wing; the word is given as printed. Against Table B: the times agree except the row of $5^h\ 8^m$ and the two rows of $5^h\ 21^m$ on February 10, which Table B does not have, and Table B's observations of February 14 to March 2 and of March 28 have no row in this table. The distances of the comet are those of Table A freed of refraction, except 37° 42′ 10″ from the Bright Star of Lyra on February 10, 39° 35′ 0″ from the Tail of Cygnus and the pair 38° 6′ 30″ and 29° 17′ 45″ on February 13, and 34° 48′ 0″ from Lyra on March 10, which Table A does not give, and 37° 22′ 40″ from the outermost star of the wing on March 10, which is Table A's observed distance (freed, 37° 22′ 38″). On February 7, 10 and 13 the longitudes and latitudes differ from those of Table B at the same times, in latitude always lower, by up to 7′ 47″; three rows of March 10 agree with Table B exactly. The values are printed as they stand and have not been recomputed.

Year 1661. Month, day	Time corrected from the altitudes, morning (h m s)	Longitude of the comet (° ′ ″, sign)	Northern latitude of the comet (° ′ ″)	Proper motion of the comet (° ′ ″)	Angle of the orbit and the ecliptic (° ′ ″)	Point of intersection with the ecliptic, or node (° ′ ″, sign)
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″	*	*	*
5	$5^h\ 6^m\ 0^s$	7° 20′ 38″ ♒	23° 51′ 55″	3° 0′ 30″	40° 51′ 0″	8° 5′ 42″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
5	$5^h\ 9^m\ 0^s$	7° 20′ 6″ ♒	23° 51′ 25″	3° 2′ 30″	41° 21′ 0″	7° 34′ 48″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			*
6	$5^h\ 25^m\ 0^s$	5° 47′ 43″ ♒	24° 35′ 0″	4° 35′ 40″	39° 3′ 37″	10° 6′ 52″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
6	$5^h\ 38^m\ 0^s$	5° 48′ 1″ ♒	24° 35′ 39″	4° 36′ 0″	39° 13′ 55″	9° 54′ 48″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			*
7	$4^h\ 48^m\ 0^s$	4° 28′ 56″ ♒	25° 16′ 43″	5° 58′ 0″	38° 49′ 40″	10° 23′ 54″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
7	$5^h\ 8^m\ 0^s$	4° 29′ 18″ ♒	25° 17′ 0″	5° 58′ 20″	38° 58′ 42″	10° 12′ 43″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			*
10	$5^h\ 5^m\ 0^s$	0° 44′ 48″ ♒	26° 39′ 42″	9° 35′ 0″	36° 40′ 2″	13° 9′ 3″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
10	$5^h\ 5^m\ 0^s$	0° 44′ 27″ ♒	26° 39′ 58″	9° 35′ 25″	36° 40′ 35″	13° 8′ 53″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			*
13	$4^h\ 58^m\ 0^s$	27° 47′ 29″ ♑	27° 26′ 13″	12° 18′ 10″	35° 7′ 55″	15° 21′ 17″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
13	$5^h\ 32^m\ 0^s$	27° 47′ 25″ ♑	27° 26′ 39″	12° 18′ 20″	35° 8′ 50″	15° 19′ 39″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
14	observation doubtful	27° 5′ 43″ ♑	27° 40′ 24″	12° 57′ 34″	35° 2′ 0″	15° 29′ 48″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
17	observation doubtful	26° 6′ 22″ ♑	28° 54′ 50″	14° 15′ 38″	37° 37′ 12″	11° 53′ 26″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			*
20	$4^h\ 55^m\ 0^s$	23° 13′ 48″ ♑	28° 8′ 1″	16° 19′ 53″	32° 54′ 6″	18° 59′ 31″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
20	$5^h\ 5^m\ 0^s$	23° 14′ 49″ ♑	28° 7′ 45″	16° 18′ 47″	32° 53′ 6″	19° 1′ 7″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			*
March 2	$3^h\ 58^m\ 0^s$	19° 7′ 37″ ♑	27° 32′ 50″	19° 41′ 48″	29° 36′ 43″	25° 43′ 56″ ♓

Year 1661. Month, day	Time corrected from the altitudes, morning (h m s)	Longitude of the comet (° ′ ″, sign)	Northern latitude of the comet (° ′ ″)	Proper motion of the comet (° ′ ″)	Angle of the orbit and the ecliptic (° ′ ″)	Point of intersection with the ecliptic, or node (° ′ ″, sign)
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
March 2	$4^h\ 2^m\ 0^s$	19° 7′ 28″ ♑	27° 32′ 58″	19° 42′ 5″	29° 36′ 50″	25° 43′ 39″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			*
March 10	$3^h\ 4^m\ 0^s$	16° 31′ 46″ ♑	27° 13′ 0″	21° 54′ 50″	28° 20′ 40″	28° 58′ 23″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			
March 10	$3^h\ 24^m\ 0^s$	16° 33′ 20″ ♑	27° 11′ 8″	21° 53′ 5″	28° 17′ 37″	29° 6′ 48″ ♓
February 3	$5^h\ 47^m\ 0^s$	10° 1′ 48″ ♒	22° 8′ 11″			*
March 28	observation doubtful	13° 0′ 0″ ♑	26° 10′ 0″	24° 57′ 0″	25° 7′ 30″	5° 5′ 17″ ♈

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Table E.

The proper motion of the comet of 1661, the angle of the orbit and the equator, with the place of their intersection.

643 Arrangement of Table D. The page sets the observations in nineteen ruled pairs of lines. The upper line of every pair repeats the observation of February 3 at $5^h\ 47^m$ (longitude 10° 1′ 48″ of Aquarius, latitude 22° 8′ 11″), and the lower line gives a later observation; the proper motion, the angle and the node stand on the lower line, and are reckoned between the two observations of the pair. Each printed line is one row here, and the figures set in separate columns of degrees, minutes and seconds (hours, minutes and seconds for the time) are joined into one cell. The month is printed in each upper line; in the lower lines only the day is printed through February 20, and the month is printed with the day from March 2 on. Asterisks stand on the upper line of the first pair over the motion, the angle and the node, and on the upper line of eight later pairs over the node, as shown; their purpose is not stated on this page. For February 14 and 17 and March 28 the time column reads observation doubtful (the last with a comma for the point) and gives no time. The longitude carries the sign of Aquarius through February 10 and the sign of Capricorn from February 13 on; the node carries the sign of Pisces, and on March 28 the sign of Aries. The longitudes and latitudes differ from those of Table C for the same times, except at $3^h\ 24^m$ on March 10, where they agree; the values are printed as they stand and have not been recomputed.

Month, day	By the clock corrected from the altitudes, morning (h m s)	Right ascension of the comet (° ′ ″)	Northern declination of the comet (° ′ ″)	Proper motion of the comet (° ′ ″)	Angle of the orbit and the equator (° ′ ″)	Node of the orbit and the equator (° ′ ″)
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
5	$5^h\ 6^m\ 0^s$	303° 49′ 0″	4° 38′ 55″	3° 1′ 0″	20° 43′ 55″	316° 12′ 13″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
6	$5^h\ 25^m\ 0^s$	302° 16′ 14″	5° 0′ 35″	4° 35′ 40″	18° 29′ 48″	317° 28′ 46″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
7	$4^h\ 48^m\ 0^s$	300° 56′ 47″	5° 24′ 45″	5° 58′ 40″	18° 26′ 42″	317° 30′ 23″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
10	$5^h\ 5^m\ 0^s$	297° 21′ 3″	6° 2′ 3″	9° 35′ 12″	15° 34′ 45″	319° 40′ 17″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
13	$5^h\ 58^m\ 0^s$	294° 36′ 8″	6° 17′ 11″	12° 18′ 0″	13° 32′ 51″	321° 45′ 33″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
14	observation doubtful	293° 56′ 44″	6° 23′ 55″	12° 57′ 51″	13° 28′ 26″	321° 51′ 13″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
17	observation doubtful	292° 51′ 33″	7° 27′ 49″	14° 15′ 38″	16° 30′ 27″	318° 45′ 28″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
20	$4^h\ 55^m\ 0^s$	290° 28′ 55″	6° 16′ 14″	16° 19′ 53″	10° 43′ 20″	326° 21′ 29″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
March 2	$3^h\ 58^m\ 0^s$	286° 57′ 33″	5° 9′ 51″	19° 41′ 48″	6° 22′ 0″	340° 53′ 36″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
March 10	$3^h\ 4^m\ 0^s$	284° 42′ 11″	4° 33′ 15″	21° 54′ 50″	4° 50′ 0″	354° 37′ 20″
February 3	$5^h\ 47^m\ 0^s$	306° 39′ 10″	3° 35′ 36″			
March 28	observation doubtful	281° 39′ 58″	3° 11′ 17″	24° 56′ 45″	3° 35′ 36″	35° 19′ 15″

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Table F.
The daily motion of the comet of the year 1661 in its orbit.

Month, day, 1661	Daily motion (° ′)	Continuous motion (° ′)	Hourly motion of each day (′ ″)
February 3	0° 0′	0° 0′	0′ 0″
4	1° 34′	1° 34′	3′ 55″
5	1° 34′	3° 8′	3′ 55″
6	1° 33′	4° 41′	3′ 52½″
7	1° 23′	6° 4′	3′ 27½″
8	1° 16′	7° 20′	3′ 9″
9	1° 10′	8° 30′	2′ 55″
10	1° 4′	9° 34′	2′ 40″
11	0° 59′	10° 33′	2′ 27″
12	0° 54′	11° 27′	2′ 15″
13	0° 49′	12° 16′	2′ 2″
14	0° 44′	13° 0′	1′ 50″
15	0° 40′	13° 40′	1′ 40″
16	0° 36′	14° 16′	1′ 30″
17	0° 33′	14° 49′	1′ 22″
18	0° 30′	15° 19′	1′ 14″
19	0° 27′	15° 46′	1′ 7″
20	0° 24′	16° 10′	1′ 1″
21	0° 22′	16° 32′	0′ 56″
22	0° 22′	16° 54′	0′ 54″
23	0° 21′	17° 15′	0′ 53″
24	0° 21′	18° 36′	0′ 52″
25	0° 21′	18° 57′	0′ 51″
26	0° 20′	19° 17′	0′ 50″
27	0° 20′	19° 37′	0′ 49″
28	0° 19′	19° 56′	0′ 48″

644 Arrangement of Table E. As in Table D, the page sets the observations in ruled pairs of lines: the upper line of each pair repeats the observation of February 3 at $5^h\ 47^m$ (right ascension 306° 39′ 10″, declination 3° 35′ 36″), and the lower line gives a later observation with the proper motion, the angle and the node reckoned between the two. Each printed line is one row here, and the figures set in separate columns of degrees, minutes and seconds (hours, minutes and seconds for the time) are joined into one cell. The month is printed in each upper line. No sign of the zodiac follows the figures in this table. The eleven pairs run from February 5 to March 28. For February 14 and 17 and March 28 the time column reads observation doubtful and gives no time, and from March 2 on the month is printed with the day in the lower line as well. The node of March 28 is printed 35° 19′ 15″, following 354° 37′ 20″ on March 10, the count having passed 360°. The time of the February 13 row is printed $5^h\ 58^m$, where Table D's rows for that day stand at $4^h\ 58^m$ and $5^h\ 32^m$; the values are printed as they stand and have not been recomputed.

Month, day, 1661	Daily motion (° ′)	Continuous motion (° ′)	Hourly motion of each day (′ ″)
March 1	0° 19′	20° 15′	0′ 47″
2	0° 18′	20° 33′	0′ 46″
3	0° 18′	20° 51′	0′ 45″
4	0° 18′	21° 9′	0′ 44″
5	0° 17′	21° 26′	0′ 43″
6	0° 17′	21° 43′	0′ 42″
7	0° 16′	21° 59′	0′ 41″
8	0° 16′	22° 15′	0′ 40″
9	0° 15′	22° 30′	0′ 38″
10	0° 15′	22° 45′	0′ 37″
11	0° 14′	22° 59′	0′ 36″
12	0° 14′	23° 13′	0′ 35″
13	0° 13′	23° 26′	0′ 33″
14	0° 13′	23° 39′	0′ 32″
15	0° 12′	23° 51′	0′ 31″
16	0° 12′	24° 3′	0′ 30″
17	0° 11′	24° 14′	0′ 28″
18	0° 11′	24° 25′	0′ 27″
19	0° 10′	24° 35′	0′ 26″
20	0° 10′	24° 45′	0′ 25″
21	0° 9′	24° 54′	0′ 23″
22	0° 9′	25° 3′	0′ 22″
23	0° 9′	25° 11′	0′ 21″
24	0° 8′	25° 19′	0′ 20″
25	0° 8′	25° 27′	0′ 19″
26	0° 7′	25° 34′	0′ 18″
27	0° 7′	25° 41′	0′ 17″
28	0° 6′	25° 47′	0′ 15″

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Table G.

A table showing, for each day, the variation of the angle of the orbit and the ecliptic, then of the equator, and also of the point of intersection.

[645] Arrangement of Table F. The page sets this table in two halves side by side under one heading repeated in each half, February 3 to 28 on the left and March 1 to 28 on the right, so that each printed line carries a day of February beside a day of March; the left half ends two lines short of the right. Here the two halves are given as two separate tables, February first and then March, so that the days read in order; each printed line of a half is one row, and the figures set in separate columns of degrees and minutes (minutes and seconds for the hourly motion) are joined into one cell. The month is printed only on the first line of each half. The continuous motion is the motion reckoned from February 3 and is carried on from February 28 into March 1. It is the running sum of the daily motions except at two lines: on February 24 the page prints 18° 36′ where 17° 15′ and 21′ make 17° 36′, and every later figure carries the extra degree; on March 23 it prints 25° 11′ where 25° 3′ and 9′ make 25° 12′, and the later figures follow 25° 11′. The hourly motion is close to the daily motion divided by 24. The values are printed as they stand and have not been recomputed.

Month, day, 1661	Angle of the orbit and the ecliptic (° ′)	Northern node of the comet (° ′, sign)	Angle of the orbit and the equator (° ′)	Node of the orbit and the equator (° ′)
February 5	40° 21′	8° 6′ ♓	20° 44′	316° 12′
6	39° 14′	10° 7′	18° 30′	317° 29′
7	38° 50′	10° 24′	18° 27′	317° 30′
8	38° 0′	11° 21′	17° 25′	318° 15′
9	37° 16′	12° 16′	16° 25′	318° 58′
10	36° 40′	13° 9′	15° 35′	319° 40′
11	36° 9′	13° 56′ ♓	14° 55′	320° 22′
12	35° 39′	14° 40′	14° 14′	321° 4′
13	35° 8′	15° 21′	13° 33′	321° 46′
14	34° 43′	15° 56′	13° 9′	322° 27′
15	34° 33′	16° 26′	12° 45′	323° 7′
16	34° 12′	16° 56′	12° 21′	323° 47′
17	33° 54′	17° 26′ ♓	11° 56′	324° 26′
18	33° 34′	17° 58′	11° 31′	325° 7′
19	33° 14′	18° 20′	11° 7′	325° 46′
20	32° 54′	18° 59′	10° 43′	326° 21′
21	31° 35′	19° 29′	10° 17′	327° 51′
22	31° 16′	20° 0′	9° 51′	329° 20′
23	30° 58′	20° 40′ ♓	9° 25′	330° 50′
24	30° 40′	21° 20′	9° 0′	332° 20′
25	30° 30′	22° 0′	8° 33′	333° 50′
26	30° 20′	22° 40′	8° 7′	335° 15′
27	30° 10′	23° 25′	7° 41′	336° 40′
28	29° 51′	24° 10′	7° 15′	338° 5′

Month, day, 1661	Angle of the orbit and the ecliptic (° ′)	Northern node of the comet (° ′, sign)	Angle of the orbit and the equator (° ′)	Node of the orbit and the equator (° ′)
March 1	29° 43′	24° 55′ ♓	6° 48′	339° 30′
2	29° 37′	25° 43′	6° 22′	340° 54′
3	29° 28′	26° 10′	6° 10′	342° 36′
4	29° 19′	26° 36′	5° 58′	344° 16′
5	29° 10′	27° 2′	5° 46′	345° 55′
6	29° 2′	27° 27′	5° 34′	347° 36′
7	28° 53′	27° 51′ ♓	5° 22′	349° 20′
8	28° 45′	28° 15′	5° 10′	351° 0′
9	28° 37′	28° 40′	4° 59′	352° 40′
10	28° 20′	28° 58′	4° 50′	354° 37′
11	28° 9′	29° 21′	4° 43′	356° 30′
12	27° 58′	29° 44′	4° 37′	358° 25′
13	27° 47′	0° 7′ ♈	4° 31′	0° 20′
14	27° 36′	0° 29′	4° 26′	2° 0′
15	27° 25′	0° 51′	4° 21′	4° 10′
16	27° 14′	1° 13′	4° 16′	6° 20′
17	27° 3′	1° 35′	4° 12′	8° 30′
18	26° 52′	1° 56′	4° 8′	10° 40′

Month, day, 1661	Angle of the orbit and the ecliptic (° ′)	Northern node of the comet (° ′, sign)	Angle of the orbit and the equator (° ′)	Node of the orbit and the equator (° ′)
19	26° 41′	2° 17′ ♈	4° 4′	12° 55′
20	26° 30′	2° 37′	4° 0′	15° 10′
21	26° 20′	2° 57′	3° 56′	17° 25′
22	26° 9′	3° 17′	[?]° 52′	19° 40′
23	25° 59′	3° 37′	3° 48′	22° 0′
24	25° 48′	3° 57′	3° 44′	24° 20′
25	25° 38′	4° 15′ ♈	3° 41′	26° 50′
26	25° 28′	4° 32′	3° 39′	29° 40′
27	25° 18′	4° 49′	3° 37′	32° 30′
28	25° 8′	5° 5′	3° 36′	35° 19′

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Table H.

Ephemeris of the motion of the comet of the year 1661, with respect both to the ecliptic and to the equator, for each day of the whole apparition.

Month, day	Daily motion in longitude (° ′)	Hourly motion in longitude (′ ″)	Daily motion in latitude (° ′)	Hourly motion in latitude (′ ″)	Daily motion in declination (° ′)	Hourly motion in declination (′ ″)	Daily motion in right ascension (° ′)	Hourly motion in right ascension (′ ″)
February 3								
4	1° 15′	3′ 10″	0° 53′	2′ 12″	0° 34′	1′ 25″	1° 23′	3′ 27″
5	1° 25′	3′ 32″	0° 50′	2′ 5″	0° 29′	1′ 12″	1° 28′	3′ 40″
6	1° 32′	3′ 50″	0° 44′	1′ 50″	0° 24′	1′ 0″	1° 33′	3′ 52″
7	1° 19′	3′ 17″	0° 40′	1′ 40″	0° 22′	0′ 55″	1° 20′	3′ 20″
8	1° 16′	3′ 9″	0° 35′	1′ 28″	0° 18′	0′ 45″	1° 18′	3′ 15″
9	1° 13′	3′ 2″	0° 30′	1′ 16″	0° 14′	0′ 35″	1° 15′	3′ 7″

646 Arrangement of Table G. The page sets this table in two halves side by side under one heading repeated in each half, February 5 to 28 on the left and March 1 to 28 on the right, so that each printed line carries a day of February beside a day of March; the left half ends four lines short of the right. Here the two halves are given as two separate tables, February first and then March, so that the days read in order; each printed line of a half is one row, and the figures set in separate columns of degrees and minutes are joined into one cell. The month is printed only on the first line of each half. The sign of the zodiac is printed only on the first line of each group of six lines and is given here where it is printed: Pisces from February 5, Aries from March 13, where the node passes 0°. The node of the orbit and the equator passes 360° between March 12 (358° 25′) and March 13 (0° 20′). The degrees of the angle of the orbit and the equator on March 22 stand on a broken sort that may be a 2 or a 3. Where Tables D and E give the same days, the angles and nodes here mostly agree with theirs to the minute; on February 5, 6 and 7 they agree only in part with Table D, and on February 14 and 17, the days whose observations Tables D and E mark as doubtful, they do not agree with either. The values are printed as they stand and have not been recomputed.

Month, day	Daily motion in longitude (° ′)	Hourly motion in longitude (′ ″)	Daily motion in latitude (° ′)	Hourly motion in latitude (′ ″)	Daily motion in declination (° ′)	Hourly motion in declination (′ ″)	Daily motion in right ascension (° ′)	Hourly motion in right ascension (′ ″)
10	1° 10′	2′ 54″	0° 26′	1′ 6″	0° 10′	0′ 25″	1° 12′	3′ 0″
11	1° 7′	2′ 47″	0° 24′	1′ 0″	0° 7′	0′ 17″	1° 0′	2′ 30″
12	1° 4′	2′ 40″	0° 22′	0′ 55″	0° 4′	0′ 10″	0° 50′	2′ 6″
13	1° 0′	2′ 30″	0° 20′	0′ 50″	0° 2′	0′ 5″	0° 42′	1′ 45″
14	0° 57′	2′ 23″	0° 18′	0′ 45″	0° 1′	0′ 3″	0° 38′	1′ 35″
15	0° 54′	2′ 16″	0° 16′	0′ 40″	0° 1′	0′ 2″	0° 37′	1′ 32″
16	0° 51′	2′ 8″	0° 15′	0′ 38″	0° 0′	0′ 0″	0° 36′	1′ 30″
17	0° 48′	2′ 0″	0° 14′	0′ 35″	0° 0′	0′ 0″	0° 35′	1′ 27″
18	0° 45′	1′ 53″	0° 13′	0′ 32″	0° 1′	0′ 2″	0° 34′	1′ 25″
19	0° 42′	1′ 45″	0° 12′	0′ 30″	0° 3′	0′ 7″	0° 33′	1′ 23″
20	0° 40′	1′ 40″	0° 11′	0′ 28″	0° 4′	0′ 10″	0° 32′	1′ 20″
21	0° 39′	1′ 37″	0° 9′	0′ 23″	0° 4′	0′ 10″	0° 30′	1′ 15″
22	0° 38′	1′ 35″	0° 7′	0′ 17″	0° 5′	0′ 12″	0° 29′	1′ 12″
23	0° 57′	1′ 32″	0° 5′	0′ 12″	0° 5′	0′ 13″	0° 28′	1′ 10″
24	0° 36′	1′ 30″	0° 4′	0′ 10″	0° 5′	0′ 14″	0° 27′	1′ 7″
25	0° 35′	1′ 27″	0° 3′	0′ 7″	0° 6′	0′ 15″	0° 26′	1′ 5″
26	0° 34′	1′ 25″	0° 2′	0′ 5″	0° 6′	0′ 15″	0° 25′	1′ 2″
27	0° 33′	1′ 23″	0° 2′	0′ 5″	0° 6′	0′ 15″	0° 24′	1′ 0″
28	0° 32′	1′ 20″	0° 1′	0′ 3″	0° 6′	0′ 15″	0° 23′	0′ 57″

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Table H.

Month, day	Daily motion in longitude (° ′)	Hourly motion in longitude (′ ″)	Daily motion in latitude (° ′)	Hourly motion in latitude (′ ″)	Daily motion in declination (° ′)	Hourly motion in declination (′ ″)	Daily motion in right ascension (° ′)	Hourly motion in right ascension (′ ″)
March 1	0° 31′	1′ 17″	0° 1′	0′ 2″	0° 6′	0′ 15″	0° 22′	0′ 55″
2	0° 30′	1′ 15″	0° 1′	0′ 3″	0° 6′	0′ 15″	0° 21′	0′ 52″
3	0° 28′	1′ 10″	0° 2′	0′ 5″	0° 5′	0′ 14″	0° 20′	0′ 50″

647 Arrangement of Table H. The page sets this table in one ruled frame, with the month printed only on the first line; February 3, the first day of the observations, carries no figures. Each printed line is one row here, and the figures set in separate columns of degrees and minutes (minutes and seconds for the hourly motion) are joined into one cell. The table runs on this page to February 28, and the catchword at the foot repeats its title. Each hourly motion agrees with the daily motion divided by 24 to within about 2″ (the daily motions being given only to the minute) on every line but one: on February 23 the hourly motion in longitude, 1′ 32″, answers a daily motion of about 37′, where the page prints 57′, and the daily motions of the days before and after (38′ on February 22, 36′ on February 24) also point to 37′. The daily motion in longitude and in right ascension is greatest on February 6, and the daily motion in declination is nil on February 16 and 17. The values are printed as they stand and have not been recomputed.

Month, day	Daily motion in longitude (° ′)	Hourly motion in longitude (′ ″)	Daily motion in latitude (° ′)	Hourly motion in latitude (′ ″)	Daily motion in declination (° ′)	Hourly motion in declination (′ ″)	Daily motion in right ascension (° ′)	Hourly motion in right ascension (′ ″)
4	0° 26′	1′ 5″	0° 2′	0′ 5″	0° 5′	0′ 14″	0° 19′	0′ 47″
5	0° 24′	1′ 0″	0° 2′	0′ 5″	0° 5′	0′ 14″	0° 18′	0′ 45″
6	0° 23′	0′ 57″	0° 2′	0′ 5″	0° 5′	0′ 13″	0° 17′	0′ 42″
7	0° 21′	0′ 53″	0° 3′	0′ 6″	0° 5′	0′ 13″	0° 16′	0′ 40″
8	0° 20′	0′ 50″	0° 3′	0′ 6″	0° 5′	0′ 13″	0° 15′	0′ 37″
9	0° 19′	0′ 47″	0° 3′	0′ 7″	0° 5′	0′ 13″	0° 14′	0′ 36″
10	0° 18′	0′ 45″	0° 3′	0′ 7″	0° 5′	0′ 13″	0° 14′	0′ 35″
11	0° 17′	0′ 43″	0° 3′	0′ 7″	0° 5′	0′ 12″	0° 13′	0′ 33″
12	0° 16′	0′ 40″	0° 3′	0′ 7″	0° 5′	0′ 12″	0° 13′	0′ 32″
13	0° 15′	0′ 37″	0° 3′	0′ 7″	0° 5′	0′ 12″	0° 12′	0′ 31″
14	0° 14′	0′ 35″	0° 3′	0′ 7″	0° 5′	0′ 12″	0° 12′	0′ 30″
15	0° 14′	0′ 34″	0° 3′	0′ 7″	0° 5′	0′ 12″	0° 11′	0′ 28″
16	0° 13′	0′ 33″	0° 3′	0′ 8″	0° 5′	0′ 12″	0° 11′	0′ 27″
17	0° 13′	0′ 32″	0° 3′	0′ 8″	0° 5′	0′ 12″	0° 11′	0′ 26″
18	0° 12′	0′ 31″	0° 3′	0′ 8″	0° 5′	0′ 12″	0° 10′	0′ 25″
19	0° 12′	0′ 30″	0° 3′	0′ 8″	0° 5′	0′ 11″	0° 10′	0′ 24″
20	0° 11′	0′ 28″	0° 3′	0′ 8″	0° 5′	0′ 11″	0° 10′	0′ 24″
21	0° 11′	0′ 26″	0° 3′	0′ 8″	0° 4′	0′ 11″	0° 10′	0′ 23″
22	0° 10′	0′ 25″	0° 4′	0′ 9″	0° 4′	0′ 11″	0° 9′	0′ 22″
23	0° 10′	0′ 24″	0° 4′	0′ 9″	0° 4′	0′ 11″	0° 9′	0′ 21″
24	0° 9′	0′ 22″	0° 4′	0′ 9″	0° 4′	0′ 10″	0° 9′	0′ 20″
25	0° 9′	0′ 21″	0° 4′	0′ 10″	0° 4′	0′ 10″	0° 8′	0′ 19″
26	0° 8′	0′ 20″	0° 4′	0′ 10″	0° 4′	0′ 10″	0° 8′	0′ 18″
27	0° 8′	0′ 19″	0° 4′	0′ 10″	0° 4′	0′ 10″	0° 7′	0′ 17″
28	0° 7′	0′ 18″	0° 4′	0′ 10″	0° 4′	0′ 10″	0° 7′	0′ 16″

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[Margin: Cometa quantum Cœli ſpatium emenſus, & quem ductũ reſpectu Æquatoris ſequutus fuerit.] *How great a space of the heavens the comet traversed, and what course it followed with respect to the equator.*

From this calculation, therefore, it is clear to everyone that the comet advanced from Eurus to Zephyrus, on a course almost parallel to the ecliptic and

[648] Arrangement of Table H, continued. The table runs on from the preceding page under its title repeated, without the caption, and gives March 1 to 28, the last day of the observations; the month is printed only on the first line. Each printed line is one row here, and the figures set in separate columns of degrees and minutes (minutes and seconds for the hourly motion) are joined into one cell. Each hourly motion agrees with the daily motion divided by 24 to within about 2½″, the daily motions being given only to the minute. The daily motions run on from February 28 without a break: in longitude and in right ascension they fall steadily, in declination they fall from 6′ to 4′, and in latitude they rise from 1′ to 4′. Added up, the daily motions in longitude from March 3 to 10 come to 2° 59′, whereas Table D's longitudes of March 2 and March 10 differ by 2° 35′ 51″; the other sums of this page agree with the places of Tables D and E to within about 4′. The values are printed as they stand and have not been recomputed.

the equator, and retrograde. For at the beginning of the apparition it was found at ♒ 10°, and at the end at ♍ 13°, its latitude remaining northern throughout, as is clear from Table B. What is most worth noting, however, is that the latitude and the declination by no means increased steadily over the whole duration, as by rights should have happened if the comet had advanced successively, in its apparent motion, beneath a circle very nearly a great circle; this is shown more clearly by its path, drawn correctly on the globe from the observations. For the latitude increased only until February 20, and after that it decreased again.

[Margin: Ex Latitudinibus & Declinationibus manifeſtum eſt, Cometam 1661 deſcripſiſſe orbitam incurvatam, vel conicam.] *From the latitudes and declinations it is clear that the comet of 1661 described a curved, or conic, orbit.*

Hence the declination too, which was 3° 36′ at the beginning and 6° 14′ in the middle, was only 3° 11′ at the end. It is therefore certain that the apparent path of this comet's course, as we have drawn it in its proper place, was by no means a section of any great circle, but an entirely curved line, or rather a conic one.

[Margin: Ex angulo inclinationis & Nodo idem evincitur.] *The same is proved from the angle of inclination and the node.*

This becomes still more evident from the place of the nodes and the angle of inclination of the orbit. For at first the node stood near the beginning of Pisces, but at the end near the beginning of Sagittarius, which will certainly seem remarkable to some. For almost the opposite must be inferred from Table D; but you should know that in the table just mentioned only the ascending node and its variation were computed, keeping in every calculation, as the foundation, the ob- **The course of the comet of 1661, from February 3 to March 28, observed at Danzig by Johannes Hevelius.**

Diagram. A full-page engraved plate, *Fig. LL.*, with its caption engraved at the top. Below the caption, the stippled figures of Delphinus at the left and Aquila across the middle, with an unlabelled arrow crossing the Eagle's left wing, and below the Eagle's head the figure of Antinous; the stars are drawn as engraved asterisks of several sizes, none of them labelled. A curved line, labelled as the comet's orbit, runs from left to right across the lower part of the plate, falling towards the right; on it stand ten star-shaped comet heads, each marked with a day. The heads of 3, 5, 6, 7 and 10 carry long tails drawn upward, those of 13, 20 and 2 short tails, and the last two heads none. The month is written once, before the 5; no month is written for the last three days. Below the figures runs a straight graduated scale, labelled as the equator, divided into small ticks with a longer tick at each figure; its figures fall from 310 at the left to 280 at the right. The labels engraved on the plate:

- *Curſus Cometæ 1661, à Die 3 Februarii, ad 28 Martii / obſervatus, GEDANI, à Iohanne Hevelio.* (top, two lines): the caption, rendered above.
- *Delphinus.* (left): Delphinus.
- *Aquila.* (above the right wing of the Eagle): Aquila.

- Along the orbit, from left to right: *3*; *Febr.* (February), with *5*; *6*; *7*; *10*; *13*; *20*; *2*; *10*; *28*.
- *Orbita Cometæ.* (below the left part of the orbit, written along it): Orbit of the comet.
- *Antinous* (below the Eagle's head): Antinous.
- Below the scale, from left to right: *310*; *300*; *290*; *280*.
- *Aquator.* (below the scale at the left): Equator.[649]
- *Fig. LL.* (lower left): Figure LL.
- *Autor ſculpsit.* (lower left): Engraved by the author.

servation of February 3, in exploring both the node and the angle of the orbit. So the point in question is not revealed.

[Margin: Inſignis anguli inclinationis variatio.] *A notable variation of the angle of inclination.*

From this we do learn the variation of the angle of inclination (keeping, that is, that observation of February 3 in every calculation): it runs to 16 degrees with respect to the ecliptic, and to 18 degrees with respect to the equator. But this variation would in fact have turned out much larger still had it been derived from two observations closer together, as you readily see.

[Margin: Cometa 1661; inter tardiſſimos meritò numeratur.] *The comet of 1661 is rightly counted among the slowest.*

As regards its proper motion in the visible orbit, this comet, as is plain from Tables D and E, is rightly placed among the slowest of this century.

[Margin: Quanta velocitas Cometis hujus Seculi obtigerit.] *How great a speed the comets of this century attained.*

For the comet of 1607 (according to the calculation of Longomontanus, *On the New Phenomena of the Heavens* [de novis cœli phænomenis], p. 29) completed 9° 40′ in a single day; the comet of 1618, on November 21 (as the same author confirms on p. 35 of the same booklet), 3° 20′; the comet of 1652, on December 20, according to our observations, 11° 16′; the comet of 1664, on December 28 and 29, 12° 51′; the comet of 1665, on April 7, 4° 6′. This comet of 1661, however, traversed only 1° 34′, and that at the place where it was fastest, namely around perigee. For at the last it ran through only 6′ in daily motion and 15″ in hourly motion, as we see from Table F.

[Margin: Cometa hic; cum cæteris omnibus, regulariſſimum continuò exercuit motum.] *This comet, together with all the others, continually exercised a most regular motion.*

For the rest, there is no doubt that, just like all the other comets mentioned in this work, this comet too exercised a motion which, though unequal both in longitude and latitude and in its proper motion, was nevertheless supremely regular and ordered, even though it possessed a notable variation of the inclination of the orbit and a progression of the nodes in the order of the signs; or,

[649] The plate prints the first letter as the same looped script capital A as in Antinous and Autor, with no e joined to it.

what is the same thing, had nodes plainly contrary with respect to the comet's proper motion.

[Margin: Paucisſimi Cometæ adverſum motum Nodorum habuerunt.] *Very few comets have had a contrary motion of the nodes.*

I would have you note, though, that the greatest part of comets have been direct as regards the motion of the nodes. For only two, namely those of 1531 and 1665, were retrograde continually through the whole time of their duration, as you will learn more fully on p. 123 of Book I, and also in Book XI, in its proper place.

[Margin: Quamdiu Cometa 1661 ab Autore ſit obſervatus.] *How long the comet of 1661 was observed by the author.*

Finally, as to its duration: this comet was seen by us for 53 whole days, namely from February 3 to March 28. I doubt whether anyone else detected it for longer; indeed, it could not have been detected much earlier either, because of its excessive nearness to the Sun. For since the arc of vision on February 3 was only about 20 or 21 degrees, and that arc, at first appearances, extends at most to 15 degrees, it follows that it could have broken out of the Sun's rays only 5 or 6 degrees earlier; and since its proper motion in the orbit was 1° 30′, it could traverse these degrees in three or four days.

[Margin: Cometa ante 1 Febr.conſpici haud potuit.] *The comet could not be seen before February 1.*

Therefore it could not be seen on our horizon before February 2 or 1, nor by others living under a higher pole; and experience does not contradict this in the least. For we have not yet ascertained whether it appeared anywhere earlier than February 2, as happened, by good fortune, at the harbour and fort of Pillau [Pillavienſi], situated at the mouth of the river Pregel [Prâgel], which flows past Königsberg in Prussia [Regiomontum Borusſiæ]. On that day, I believe, it would have been detected here at Danzig no less, had we had a more favourable sky.

[Margin: Longitudo itineris Cometæ 1661.] *The length of the path of the comet of 1661.*

Over its whole course, however, it traversed no more than 25° 47′ in its orbit, as is clear from Table F. This indeed seems a small space of path compared with the other comets, which completed much longer ones; but of the apparent motion, more than enough.

[Margin: Intervallum Cometarum à Terrá utiqúe explorari datur.] *The distance of comets from the Earth can certainly be investigated.*

Let us go on to investigate its true distance from the Earth, so that it may become known whether this comet too, like all the others we have brought on stage in this work, was ethereal, and how great a space it was actually removed from us. This is indeed hard to find out, above all if you rely on wavering observations; if, on the contrary, you have sound and certain ones, it can certainly be investigated, though not without a lengthy calculation and the troublesome labour of investigating the parallaxes.

[Margin: Non unâ eâdemq; ratione in Cometis parallaxes explorantur.] *In comets the parallaxes are not investigated by one and the same method.*

These parallaxes could indeed be derived for this comet in different ways; but since we are aiming at brevity, and would by no means detain the kind reader any longer with most tiresome and most extensive figures, we have this time taken a shorter road.

[Margin: Parallaxes compendiosâ viâ hîc exploratæ ſunt.] *Here the parallaxes are investigated by a short route.*

For I set out to examine the difference of parallax at different altitudes, and thus the horizontal parallax, as was done on p. 48 of the *Description of the Comet of 1665* [Deſcript. Com. 1665]. For by the more lengthy method by which we undertook the task for the comet of 1652, namely from certain distances from the fixed stars, taken on the same day once parallel and once vertical, we shall in no way reach our goal with this comet. For it was never visible to us for a whole night, nor even for half a night, but showed itself for scarcely one short hour or two.

[Margin: Cum datis, producta tatùm calculi parallactici exhibita ſunt.] [recte: tantùm] *Only the results of the parallactic calculation are shown, together with the data.*

There is no need to set out here the method of this parallactic calculation, since we have already shown it in the place just cited; I shall only enter in a table the data and the results that bear on this matter, so that if any doubt should perhaps occur to anyone, he may be able to examine everything the more precisely and bring it back to the anvil once more; although I do not doubt that everything has been correctly found.

[Margin: Diſtantiæ verticales quomodo obtineantur.] *How the vertical distances are obtained.*

The matter does, however, require me at least to touch briefly on the way I obtained those vertical distances, which were not observed with the sextant as often as would indeed have been needed. I did, however, find those intervals from a certain fixed star, more conveniently placed at that time, by calculation (which comes to the same thing): namely from the true place of the comet, cleared of refractions and observed at different times. This you should particularly note.

[Margin: Modus brevior parallaxes eruendi ex diſtantiis verticalibus.] *A shorter way of deriving the parallaxes from vertical distances.*

For with any comets that come your way, even if you have not managed to obtain any such distances with proper instruments, you can nonetheless derive them by the method just described, for investigating the parallaxes. Now, this distance was that of the Bright Star of Lyra [Lucidæ Lyræ]; for this star stood with the comet under one and the same vertical almost the whole time of its appearance, as will be clear from a globe. I therefore did not at all find it necessary to reduce these distances to the vertical, as was done for the comet of 1652, but simply to free one distance from the proper motion. This

distance, subtracted from the other distance, which is subject to the proper motion, at once yields the difference of parallax between two different altitudes of the comet, belonging to those different times at which the distances were ascertained. From this parallax, with the help of our Table of Parallax given in Book III, p. 141, I have found, with all tedious calculation removed, the horizontal parallax, and so also the true distance itself of this comet from the Earth, set out in the following short table.

Table I. Parallaxes and distances of the comet of 1661 from the Earth
[TABULA I. Parallaxes & Diſtantiæ à Terrâ Cometæ 1661.]

Month, day	Corrected time, morning	Longitude of Lyra	Northern latitude of Lyra	Longitude of the comet	Northern latitude of the comet	Distance of the comet from Lyra, cleared of all refraction	Altitude of the comet	Distances from Lyra, freed from the proper motion	Parallax of the difference of altitude	Horizontal parallax	Distance of the comet from the Earth, in semidiameters of the Earth
April 3	$5^h\ 47^m$	0° 34′ 61″ ♑ 27′ 30″	4′ 33″ ♒	2′ 42″	4° 36′ 0″	7° 30′					
	$6^h\ 19^m\ 59^s$		10° 5′ 12″ ♒	2′ 54″	4° 35′ 38″	9° 15′	44° 35′ 38″	0½″	1′ 43″	2000
April 5	$5^h\ 6^m$	0° 34′ 61″ ♑ 27′ 30″	26′ 28″ ♒	43′ 9″	4° 13′ 28″	5° 0′	42° 13′ 28″	0½″	1′ 22″	2500
	$5^h\ 47^m\ 0^s$		7° 25′ 42″ ♒	47′ 0″	4° 9′ 35″	11° 0′				
April 6	$5^h\ 25^m$	0° 34′ 61″ ♑ 27′ 30″	47′ 26″ ♒	28′ 34″	4° 2′ 5″	10° 0′	41° 2′ 5″	0″	1′ 17″	2800
	$5^h\ 45^m\ 0^s$		5° 46′ 82″ ♒	30′ 54″	3° 59′ 35″	13° 0′				
April 7	$4^h\ 48^m$	0° 34′ 61″ ♑ 27′ 30″	29′ 46″ ♒	3′ 12″	4° 7′ 45″	7° 0′	40° 7′ 45″	0″	1′ 9″	3000
	$5^h\ 34^m\ 0^s$		4° 29′ 25″ ♒	0′ 34″	4° 0′ 42″	13° 0′				
April 10	$5^h\ 5^m$	0° 34′ 61″ ♑ 27′ 30″	50′ 12″ ♒	34′ 39″	4° 44′ 18″	14° 0′	37° 44′ 18″	0″	0′ 59″	3500
	$5^h\ 21^m\ 0^s$		0° 47′ 36″ ♒	35′ 13″	4° 42′ 53″	16° 0′				
April 13	$4^h\ 36^m$	0° 34′ 61″ ♑ 27′ 30″	46′ 29″ ♒	24′ 35″	4° 14′ 42″	14° 0′	36° 14′ 42″	0″	0′ 52″	4000
	$5^h\ 32^m\ 0^s$		27° 48′ 26″ ♑	36′ 13″	4° 12′ 42″	19° 0′				
March 2	$3^h\ 58^m$	0° 34′ 61″ ♑ 27′ 30″	7′ 32″ ♑	2′ 59″	4° 43′ 0″	22° 0′	34° 43′ 0″	0″	0′ 29″	7000
	$4^h\ 34^m\ 0^s$		19° 4′ 32″ ♑	33′ 48″	4° 41′ 13″	25° 0′				
March 10	$3^h\ 4^m$	0° 34′ 61″ ♑ 27′ 30″	34′ 26″ ♑	6′ 34″	4° 51′ 17″	22° 0′	34° 51′ 17″	0″	0′ 23″	9000
	$3^h\ 24^m\ 0^s$		16° 33′ 29″ ♑	8′ 34″	4° 51′ 17″	24° 0′				

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[Margin: Singulis diebus Cometa 1661 diverſam retulit parallaxin.] *On each day the comet of 1661 showed a different parallax.*

Since, then, I have derived the parallaxes by calculation for a great many different days, it is easy to gather that the comet had a very different parallax on each single day.

[Margin: Quanto intervallo Cometa [[à/á]] Terrâ remotus fuerit.] *How great an interval the comet was removed from the Earth.*

For at the beginning the parallax itself was 1′ 43″, but at the end only 23″. That is, at its first rising the comet was only 2000 semidiameters of the Earth away from the Earth, but at its departure 9000 semidiameters; so that at first it was much nearer to us, but afterwards far more remote, and from day to day it went on to higher regions.

[Margin: Liquidum eſt, Cometam æthereum fuisſe.] *It is clear that the comet was ethereal.*

[Margin: Quantò Lunâ fuerit remotior.] *How much more remote than the Moon it was.*

[Margin: Cometa orbem Mercurii Vener. & Martis fermè pervagavit.] *The comet ranged almost through the orb of Mercury, Venus and Mars.*

But whether this comet had its seat in the air or in the ether, there is certainly no call for us to try to demonstrate at length. For since, even at the time when it was nearest the Earth, it was more than 33 times more remote, or higher, than the Moon, even supposing that the Moon is 60 semidiameters of the Earth distant from us, it follows with certain and infallible necessity that this phenomenon completed its course in the highest ether, like all the others mentioned here and there in the preceding books. And if we consider the matter somewhat more deeply, given, namely, our hypothesis and a distance of the Sun from the Earth of 5157 semidiameters of the Earth, the comet at its origin dwelt in the orb of Mercury; around the end of April it had already reached the Sun itself; and at its last appearance it had traversed almost the whole orb of Mars, in the outermost part of which orb it finally vanished. Whether it was entirely extinguished there, or rather made for more remote regions, I cannot affirm, since it was not granted to observe it any longer.

650 The table is ruled in twelve columns, with italic heads; the heads are rendered in English, and the unit row printed beneath them (hours, minutes and seconds; degrees, minutes, seconds and sign; degrees and minutes for the altitude; seconds for the tenth column; minutes and seconds for the eleventh; semidiameters of the Earth for the last) is carried by the notation of the cells. Each date takes two printed lines, one for each observation time; the figures of the last four columns stand once for each date, on the first line except for April 3, where they stand on the second. The month is printed Apr. or April. for the first six dates and Mart. for the last two, and is rendered as printed. The sign marks are given as printed. The tenth column prints 0 with a small 1 over 2 for April 3 and April 5, and a bare 0 for the other dates.

[Margin: Facies capitis caudæq; Cometæ 1661. Lib. VII & VIII traduntur.] *The appearances of the head and tail of the comet of 1661 are given in Books VII and VIII.*

Now the order seems to require that we also set out, somewhat more fully than was done in the general description, the constitution of the head and of its nuclei, and their particular and momentary alteration and change; likewise the appearance of the tail, and what depends on it. But since already in Book VII, p. 416, the more specific observations of the head, and also the tail's most diverse appearances were presented on p. 458 of Book VIII, I consider it superfluous to repeat them here.

[Margin: Deviationes Caudæ Lib. XI exhibentur.] *The deviations of the tail are presented in Book XI.*

What remains to be said about the deviation of the comet's tail, and to be noted from calculation, we put off to the following Book XI. There we have decided to set out the deviations of the other two more recent comets together in one short table and to place them before the eye, as was done in Book VIII, p. 488, for the six preceding comets. In that place we likewise reserve the true length of this tail, so that it too may be displayed in one and the same table with the true tail lengths of the subsequent comets.

[Margin: Et curvus omninò motus Cometarum per rectam penè Trajectoriam ſalvatur.] *Even an entirely curved motion of comets is saved by a nearly straight trajectory.*

Now that the apparent motion has been investigated amply enough, it follows that, from the same observations and the places found, we should now also construct the theory according to the method given in Book IX. In this way it will become clear that this phenomenon too, though it describes so curved, indeed almost conic, an apparent orbit, can be freed from all inconveniences and absurdities by a nearly straight line.

[Margin: Solo Schematis ductu, tàm Interval · lum à terrâ, quàm verus motus ſatis præcisè detegitur.] *By the drawing of the diagram alone, both the interval from the Earth and the true motion are found quite precisely.*

And first, mechanically. This is indeed very easy to do; and yet, once the figure has been duly drawn in proportion to the annual orbit, each and every thing, both the interval from the Earth and the true motion in the trajectory, is found quite accurately by means of the proportional compasses [circino proportionum], so that anyone who takes no account of the smallest details can be very well content with what is found in this way. For you will stray very little from the true mark even if you neglect all figures entirely, as we shall show at once by an example. Once the distance of the Sun from the Earth, 5157 semidiameters of the Earth according to our hypothesis, has been transferred to the proportional compasses, all the lines, such as A H, B I, C K, or whichever you wish, are revealed at once without any trouble, and indeed so accurately that there is scarcely any need to know them more accurately. This is abundantly clear from the distances, set out here, of the perpendiculars falling

from the comet onto the trace of the trajectory, measured from the centre of the Earth, if, that is, you compare these with those derived from the calculation that follows.

February 3	A H	1920
6	B I	2330
10	C K	3010
20	D L	4730
March 2	EM	6330
10	FN	7500
28	GO	8950

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[Margin: Operoſum eſt calculo illa omnia eruere.] *It is laborious to derive all these things by calculation.*

To investigate all this properly and carefully by calculation, however, is far more laborious and troublesome, and it also demands a well-practised computer, because of the various uncommon cases that arise in that calculation. How it should be carried out, both by lines and by numbers, we have already taught amply enough in Book IX, on the occasion of the comet of 1652, p. 592 and following, and made plain by a clear example on p. 598.

[Margin: Ratione Lib. IX traditâ, Theoria conſtructa, calcu· lusq́; expeditus eſt.] *The theory has been constructed, and the calculation carried out, by the method given in Book IX.*

We have followed that method now as well, both in constructing the diagram and in setting out the calculation. Let us therefore set down here only the hypothesis itself, in a drawing, with two tables showing the data and the results.

[Margin: Explicatio Schematis.] *Explanation of the diagram.*

In the attached figure, S represents the Sun; A E G M the great orb, in which the Earth moves; A B C D E, etc., the Sun's eccentric radii.

[Margin: Interſectio veſtigii Trajectorii, quo loco accidat in Cometa 1661[[./,]]] *Where the intersection of the trace of the trajectory occurs in the comet of 1661.*

The lines drawn from the places of the Earth are the lines of sight, which in this comet nowhere intersect one another, even though in most comets, by and large, the contrary happens. The line X H I K, however, marks the trace of the trajectory, and the point X the intersection, at ♋ 24° 46′, the Earth, that is, being at ♐ 26° 1′. The trajectory itself therefore falls within the annual orbit

[651] This small table stands beside the following paragraph, at the left, with no title and no column heads; it is ruled in three columns (day, the pair of letters naming a line of the figure, and a figure of four places), with a rule under the date 20 dividing the February dates from the March dates, and a rule across its foot. The month is printed Febr. on the first line and Mart. on the fifth, and is rendered in English; the letters are given as printed.

[orbem annnum] [recte: annuum], that is, between the Sun and the Earth, just as

Diagram. A full-page engraved plate: the theory of the comet of 1661 drawn as a line diagram. At the lower left, S marks the Sun, from which lines spread to the right. The Earth's annual orbit is an arc rising from X at the lower left through the points A, B, C, D, E, F and G, with dates written beside the lines drawn to them. Two lines are labelled as lines of sight, and the far ends of seven lines at the upper and lower left carry positions in longitude. Lines labelled as the trajectory pass through the middle of the figure, where the capitals L, M and N stand at crossings of lines, and a long line at the top ends in the point O. On the right, a vertical line labelled as the trace of the trajectory carries the letters H, I, K, L, M, N and O with their dates, joined by dotted lines to the small letters c to i on the slanting line to their left. At the foot, a separate construction on a horizontal base marks A, B and C, from which three oblique lines rise; the small letters c, d and e on these lines are joined by dotted lines to H, I and K on the base, with the dates 3, 6 and 10. The title stands at the upper left, the caption Fig. MM. at the right of centre, and the engraver's line at the lower right.

- Title (upper left): Theory of the comet of the year 1661, observed by Johannes Hevelius. [Theoria Cometæ Anno 1661, à Johanne Hevelio obſervati.]
- Comet's positions (far ends of the lines of sight, set sideways, reading upward; from the left at the top): ♒ 0° 45′; ♍ 23° 14′; ♍ 19° 8′; ♍ 16° 32′; ♍ 15° 0′; (lower left) ♒ 5° 48′; ♒ 10° 2′
- O (top of the long line at the top of the figure)
- Small letters at the left ends of the dotted lines (set sideways; from the top): i, h, g, f, e, d, c
- Scale on the right (dates and letters, set sideways; from the top): 28 O; 10 N; 2 M; 20 L; 10 K; 6 I; 3 H
- Words along the scale line (reading upward, one label in two parts): Trace [Vestigium] (lower part) … of the trajectory. [Trajectoriæ.] (upper part)
- Lines of sight (two labels): Line of sight. [Linea Viſoria.]
- Along a line beside M: Of the trajectory. [Trajectoriæ.]
- Along the line beside f at the lower right: Trajectory. [Trajectoria.]
- Along the orbit, near A: Orbit [Orbis]; further up the arc: Annual … of the Earth. [Annuus] [Terræ.] (together, the annual orbit of the Earth)
- Dates on the orbit: February 3 (at A); 6 (B); 10 (C); 13 (on a line between C and D, with no letter); 20 (D); March 2 (E); 10 (F); 28 (G)
- Points of the orbit: X, A, B, C, D, E, F, G
- Along the line from S at the lower left: Solar eccentric.
- Along the line from H toward the lower left: Trace [Vestigium]
- Points on the lines from the Sun: K, I, H
- Points where lines of sight cross the trajectory: N, M, L
- S (the Sun, lower left)

- Lower construction: the base line with X, A, B, H, C, I and K. below it; c, d and e on the oblique lines; 3, 6 and 10 beside the dotted lines
- Caption (right of centre): Fig. MM.
- Engraver's line (lower right): Engraved by the author.

has been noticed in most of the comets presented in this work; for only those of the years 1585, 1652 and 1664 passed outside the limits of the great orb.

[Margin: Cometa hic intra orbem annuum curſum ſuum duxit.] *This comet ran its course within the annual orbit.*

In this comet the trace of the trajectory could not be drawn in a far different way, nor much nearer to the Earth or the Sun, nor at almost any other angle of inclination between the trajectory and the lines of sight. Otherwise the daily motion in the trajectory would in no way have been uniform, nor would the longitudes and latitudes sought from the hypothesis have agreed entirely with the rest, those from the observations.

Moreover, following the construction of the preceding diagram, the heights of the perpendiculars Hc, Id, Ke, etc. were also investigated, namely from the given observed latitudes, in the way we showed on p. 594, so that I might find the position of the genuine trajectory and its inclination to the trace, or plane, of the ecliptic.

[Margin: Inclinatio Trajectoriæ fuit in hoc Cometâ variabilis.] *The inclination of the trajectory was variable in this comet.*

This angle, however, comes out from the mechanical operation as 24° 30′ at the beginning and 17° at the end, so that it evidently varied, which should be well noted.

[Margin: Trajectoria ex part[[e/o]] curva extitit.] *The trajectory was partly [?] curved.*

And although, in various positions, now nearer to the Earth, now more remote, I tried by every better means to avoid this difference in the angle, I nevertheless achieved nothing whatever, but found it variable throughout the whole duration; and so I could in no way reduce the true trajectory itself to an entirely straight line.

[Margin: Quo locoTrajectoria ſe maximè inflexerit.] *Where the trajectory bent most.*

At the beginning, indeed, up to February 20, the curvature of the trajectory is only very slightly detectable; at the end, however, it leans most evidently towards the plane of the ecliptic, and the more so, the nearer the trace comes down towards the Earth. Indeed, even if I had carried it to more remote positions, I would nevertheless [?] have achieved anything at all; rather, I would have exposed the whole hypothesis to inconveniences, since neither the true motion in the trajectory, nor the longitudes, nor the latitudes from the hypothesis would have agreed properly with the observed ones.

[Margin: Cùm Trajectoria reverà incurvata extiterit, haud poteſt motus per tangentes rectè derivari.] *Since the trajectory was in fact curved, the motion cannot be correctly derived by tangents.*

Hence in this comet too it becomes plain that its trajectory in no way at all proceeds entirely in a straight line, even though very many, who strive to save comets by an entirely straight line of tangents, think so; but it is in fact curved of itself and almost conic, as has been said and proved on pp. 658 and 670 of the preceding Book, and elsewhere.

Let us also add shortly what the calculation of this theory yields, provided that we first set out those various angles that serve the calculation, deduced directly, namely, from the known longitude of the Sun and of the comet, together with the subtenses of the motions of the Earth in its great orb.

[Margin: Subtenſæ motûs Terræ peculiari Tabellâ traduntur.] *The subtenses of the Earth's motion are given in a special short table.*

Since, however, those subtenses of the Earth's motion had to be applied so many times, both to these and to the other preceding comets, and, besides, it is very tedious to compute them from first principles every time, in every case where it is needed, I therefore thought it not beside the point to construct a special table containing the subtenses of the motion in the eccentric up to 120°, the radius of the Earth's annual orbit being taken as 5157. I had intended to attach it in Book IX, p. 593, and to set it before the calculation there, for the use, namely (as can be read there), of all the subsequent comets; but in haste it was entirely forgotten.

[Margin: Subteuſas exploratas ha. bere, Calculatoribus multùm prodeſt.] [recte: Subtenſas] *To have the subtenses ascertained is of great benefit to calculators.*

Accordingly, what belongs to that place I shall report in this one: above all because three comets whose calculation is to be set out still remain, and then because this table may greatly benefit our successors in similar business with comets, and labour by no means com- mon it may save, for those, I mean, who do not disdain our hypothesis and the distance of the Sun from the Earth. For, given only the motion of the Earth in whole degrees, you will at once find the corresponding subtense in the attached table; and although parts [partes] or minutes are added, you can nevertheless extract any subtense by properly working out the proportional part [innitâ] [recte: initâ], as is easy to understand.

Table K. [TABULA K.]

Showing the subtenses of the motion of the Earth in the eccentric, the radius of the annual orbit being taken as 5157 semidiameters of the Earth. [Exhibens Subtenſas Motus Terr. in Eccentrico, poſito radio orbis annui 5157 Semid. Terræ.]

Mo- tion	Sub- tense	Diff.	Mo- tion	Sub- tense	Diff.	Mo- tion	Sub- tense	Diff.	Mo- tion	Sub- tense	Diff.
S. T.	Sem.Ter.	S. T.	S. T.	Sem.Ter.	S. T.	S. T.	Sem.Ter.	S. T.	Sem.T.	Sem.Ter.	S. T.
0	0		30	2669		60	5157		90	7293	
1	90	90	31	2756	87	61	5235	78	91	7356	63
2	180	90	32	2843	87	62	5312	77	92	7419	63
3	270	90	33	2929	86	63	5389	77	93	7481	62
4	360	90	34	3015	86	64	5466	77	94	7543	62

Motion	Subtense	Diff.	Motion	Subtense	Diff.	Motion	Subtense	Diff.	Motion	Subtense	Diff.
5	450	90	35	3101	86	65	5542	76	95	7604	61
6	540	90	36	3187	86	66	5617	75	96	7665	61
7	630	90	37	3273	86	67	5692	75	97	7725	60
8	720	90	38	3358	85	68	5767	75	98	7784	59
9	809	89	39	3443	85	69	5842	75	99	7843	59
10	899	90	40	3528	85	70	5916	74	100	7901	58
11	989	90	41	3612	84	71	5989	73	101	7959	58
12	1078	89	42	3696	84	72	6062	73	102	8016½	57
13	1167	89	43	3780	84	73	6135	73	103	8072	56
14	1257	90	44	3864	84	74	6207	72	104	8128	56
15	1346	89	45	3947	83	75	6279	72	105	8183	55
16	1435	89	46	4030	83	76	6350	71	106	8237	54
17	1524	89	47	4113	83	77	6421	71	107	8291	54
18	1613	89	48	4195	82	78	6491	70	108	8344	53
19	1702	89	49	4277	82	79	6561	70	109	8397	53
20	1791	89	50	4359	82	80	6630	69	110	8449	52
21	1880	89	51	4440	81	81	6699	69	111	8500	51
22	1968	88	52	4521	81	82	6767	68	112	8551	51
23	2056	88	53	4602	81	83	6834	67	113	8601	50
24	2144	88	54	4682	80	84	6901	67	114	8650	49
25	2232	88	55	4762	80	85	6968	67	115	8699	49
26	2320	88	56	4802	80	86	7034	66	116	8747	48
27	2408	88	57	4921	79	87	7100	66	117	8794	47
28	2495	87	58	5000	79	88	7165	65	118	8841	47
29	2582	87	59	5079	79	89	7229	64	119	8887	46
30	2669	87	60	5157	78	90	7293	64	120	8932	45

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Table L. [TABULA L.]
Showing various angles of the Comet of 1661. [Exhibens varios angulos Cometæ M DC LXI.]

[652] The table is ruled in twelve columns, in four groups of three, each group headed Motion, Subtense and Difference; the heads are given in English, and the units below them as printed (S. T. and Sem.Ter., semidiameters of the Earth, set under all three columns of the first three groups, Sem.T. under the Motion column of the fourth). The page prints Motus in the first three groups abbreviated with the us sign and in full in the fourth. Each difference is printed between the two lines whose subtenses it separates, about half a line lower than the upper of them; here it is set on the line of the lower subtense, so the first line of each group carries none. Rules divide each group after its fourth line and after every third line after that, and close the foot; no foot row of labels. The fraction after 8016 is printed as a small 1 over a small 2.

At about 5^h in the morning, on the current day	Longitude of the comet, observed	Latitude of the comet, observed	Motion of the comet from the intersection X	Eccentric longitude of the Sun	Motion of the Earth from X	Complements of half the motion of the Earth	Elongation of the comet from the Sun, or difference of the longitudes of the comet and the Sun	Angle of the lines of sight with the subtenses of the motion of the Earth	Angle of the trajectory with the subtense of the motion of the Earth	Complements of these angles	Subtense of the motion of the Earth
											S. T.
X	8ˢ 26° 1′			9ˢ 24° 46′			28° 45′				
February 3	10ˢ 10° 22′	2° 8′ *B.*	44° 1′	10ˢ 13° 46′	0° 0′	80° 30′	3° 44′	84° 14′	51° 45′	128° 15′	1702
6	10ˢ 5° 48′	4° 35′	39° 47′	10ˢ 16° 43′	2° 57′	79° 2′	10° 55′	89° 57′	50° 17′	129° 43′	1964
10	10ˢ 0° 45′	6° 40′	34° 44′	10ˢ 20° 39′	5° 53′	77° 4′	19° 54′	96° 58′	48° 19′	131° 41′	2310
13	9ˢ 27° 47′	7° 26′ *B.*		10ˢ 23° 38′	7° 50′	75° 35′	25° 48′		46° 50′	133° 10′	2567
20	9ˢ 23° 14′	8° 8′	27° 13′	11ˢ 0° 29′	9° 43′	72° 9′	37° 15′	109° 24′	43° 24′	136° 36′	3163
March 2	9ˢ 19° 8′	7° 33′	23° 7′	11ˢ 10° 14′	11° 32′	67° 14′	51° 10′	118° 24′	38° 29′	141° 31′	3991
10	9ˢ 16° 32′	7° 13′ *B.*	20° 31′	11ˢ 18° 9′	13° 23′	63° 19′	61° 38′	124° 57′	34° 34′	145° 26′	4633
28	9ˢ 13° 02′	6° 10′	16° 59′	0ˢ 5° 55′	17° 9′	54° 26′	82° 55′	137° 21′	25° 41′	154° 19′	6000
			AHX		XSA	SXA	SAH	XAH	AXH		XA
			BIX		XSB	SXB	SBI	XBI	BXI		XB
			CKX		XSC	SXC	SCK	XCK	CXK		XC
			DLX		XSD	SXD	SDL	XDL	DXL		XD

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Table M. [TABULA M.]

Showing the main points of the calculation for the Comet of 1661. [Calculi capita exhibens Cometæ M DC LXI.]

653 The table is ruled in twelve columns, not in groups of three as Table K is, and each column has its own head in italic, of one to seven lines, given here in English as one head each. Below the heads the page prints a unit line: S. Gr. Min. (signs, degrees, minutes) over the observed longitude of the comet and the eccentric longitude of the Sun, Gr. Min. (degrees, minutes) over the other angle columns, and S. T. (semidiameters of the Earth) over the subtenses; the signs, degrees and minutes are written here in the house notation, a sign being 30°, and only S. T. is kept as a unit line. The first line of figures is headed X, not by a date, and gives the comet's longitude, the Sun's longitude and the elongation at the intersection X. The first column prints the month only at the first date of each month. Blank cells are blank on the page: the row X carries figures in three columns only, and the row for the 13th of February has no motion of the comet from X and no angle of the lines of sight. Below the dated rows, above the foot rule, four rows of capital letters name, for the first four dates, the angle or line of the figure each column gives; they are set as rows of the table, as printed, with no figure cited for them on this page. The latitudes carry the italic *B.* only on the 3rd and 13th of February and the 10th of March. Rules divide the rows after the unit line, after the row X, after the 10th and 20th of February, after the 28th of March, and close the foot; no other foot row of labels.

At about 5^h in the morning, on the current day	Longitude of the comet, observed	Latitude of the comet, observed	Longitude of the comet from the hypothesis	Latitude of the comet from the hypothesis	Distance of the perpendicular from the comet in the trace of the trajectory, from the centre of the Earth	Distance of the same perpendicular from the intersection of the annual orbit and the trace of the trajectory	Height of the same perpendicular	True daily motion of the comet in the trajectory	Distance of the comet from the centre of the Earth	Angle of obliquity of the trajectory, or of the trace, from a straight line
					Semid. Terræ.	Semid. Terræ.	Semid. Terr.	Semid. Terr.	Semid. Terr.	
February 3	10° 2′ ♒	22° 8′ *B.*	10° 2′ ♒	22° 8′ *B.*	AH 1924	XH 2437	Hc 782	cd 699	Ac 2077	25° 15′
6	5° 48′	24° 35′	5° 48′	24° 35′	BI 2361	XI 3069	Id 1080	de 991	Bd 2596	24° 47′
10	0° 45′	26° 40′	0° 45′	26° 40′	CK 3028	XK 4024	Ke 1521	ef 2723	Ce 3388	21° 36′
20	23° 14′ ♓	28° 8′ *B.*	23° 6′ ♓	27° 57′ *B.*	DL 4752	XL 6549	Lf 2541	fg 2562	Df 5388	21° 15′
March 2	19° 8′	27° 33′	19° 8′	27° 45′	EM 6326	XM 8942	Mg 3452	gh 1932	Eg 7135	12° 8′
10	16° 32′	27° 13′	16° 32′	27° 11′	FN 7510	XN 10830	Nh 3858	hi 3131	Fh 8779	9° 29′
28	13° 0′ ♓	26° 10′ *B.*	13° 0′	26° 10′ *B.*	GO 8903	XO 13920	Oi 4374	ik	Gi 9919	

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This calculation now shows amply that the given hypothesis is not so very unsuitable and out of place. For the derived longitudes and latitudes agree extremely well with those from the observations, except that those latitudes are somewhat smaller than these, namely in the middle of the course. This comes about because I supposed the trajectory to be an entirely straight line, whereas in truth it displays an obliquity: from which the intermediate latitudes are necessarily diminished. But if I had laid down the trajectory as curved in due measure, no-

654 The table is ruled in eleven columns, each with its own italic head of two to seven lines, given here in English as one head each. The unit line prints Gr. Min. S. (degrees, minutes, sign) over the two longitude columns and Gr. Min. over the latitudes and the last column, written here in the house notation with the printed sign of the zodiac after the minutes, and Semid. Terræ. or Semid. Terr. (semidiameters of the Earth) over the five distance columns, kept as printed. A sign stands only where the page prints one; the cells without one are blank of it on the page. In the five distance columns each cell opens with a pair of letters, the line of the figure whose length it gives, followed by the figure; the X of the seventh column is set in a sloped capital, the other letters upright. Blank cells are blank on the page: on the 28th of March the daily motion has its letters ik and no figure, and the angle of obliquity is empty. The table has no row for the 13th of February, which Table L carries. Rules divide the rows after the unit line, after the 10th of February and after the 10th of March, and close the foot; no foot row of labels.

[Margin: Ex calculo patet Theoriæ cum Cœlo convenientia.] *The calculation shows that the theory agrees with the heavens.*

[Margin: Latitudines Cometæ; evidenti ſunt argumento Trajectoriæ obliquitatis.] *The latitudes of the comet are clear evidence of the obliquity of the trajectory.*

thing is in doubt: the latitudes sought would have come out far more accurately. Moreover, the distance from the centre of the Earth of the perpendiculars from the comet to the trace, and their height, as well as the distance from the Earth, also agree very well with the diagram. At the beginning, namely on February 3, the comet according to our calculation and hypothesis was 2077 semidiameters of the Earth away from the Earth; at the end, namely on March 28, 9919 semidiameters of the Earth. Whether these distances answer badly or well to the genuine parallaxes, and to the distances from the Earth derived from the observations themselves, I leave to others to judge from the following little table.

[Margin: Schema & calculus cum obſervationibus concordant.] *The diagram and the calculation agree with the observations.*

1661.	Intervals from the observations	Intervals from the hypothesis
	Sem.Ter.	Sem.Ter.
February 3	2000	2077
6	2800	2596
10	3500	3388
March 2	7000	7135
10	9000	8779

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Hence it is clearly proved that, given exquisite observations, a properly constructed hypothesis and a duly conducted calculation, one cannot depart far from the truth with this theory of ours, as regards the parallaxes and the distances of the comet from the Earth. That is altogether impossible for others to discover and determine by tangents. I grant, indeed, that they can find a certain proportion with respect to the perigee, namely how many times farther away the comet was on this day or that; but as long as the distance when the comet is at perigee is entirely unknown, the distances of the remaining days are likewise wholly hidden from us.

[Margin: Juxta Autoris hypotheſin, datis exquiſitis obſervationibus, haud poſſumus longè à vero ratione Intervallorum diſcedere.] *According to the author's*

[655] The table has no caption of its own; the sentence before it calls it the following little table, and it stands at the left of the text block with the next paragraph set beside it. It is ruled in three columns. The first column is headed only by the year, 1661., and prints the month at the first date of each month. Each of the other two columns has an italic head ending in the unit Sem.Ter. (semidiameters of the Earth), kept here as printed on a line of its own. The figures in the third column are the distances of the comet from the centre of the Earth printed in Table M for the same five dates; the table has no row for the 20th of February or the 28th of March, which Table M carries.

hypothesis, given exquisite observations, we cannot depart far from the truth as regards the distances.

[Margin: Intervallum Cometæ à terrâ, ex Theoriâ tangent. planè ignoratur.] *The distance of the comet from the Earth is entirely unknown from the theory of tangents.*

Furthermore, from the last little column of the calculation one sees in what way the angle of obliquity of the trajectory, or of the trace, from a straight line varied from day to day; that is, how much the trajectory was curved. For if it had extended itself entirely in a straight line, this angle would always have remained the same; yet it decreased gradually from 25° to 9°. Everyone must therefore be persuaded that all comets curve their trajectory, and indeed always towards the Sun, though one more or less than another: as is not only clearly shown in this comet, but has also been most plainly confirmed in others in the preceding Book, p. 678. Where this bending of the trajectory comes from, however, we have already shown in its proper place; I refer the reader there.

[Margin: Ex angulo obliquitatis,incurvatio Trajectoriæ cognoſcitur.] *From the angle of obliquity the curving of the trajectory is known.*

[Margin: In omnibus CometisTrajectoria obliquatur.] *In all comets the trajectory is made oblique.*

All the rest likewise follow according to the calculation, consistently and in order, as the observations show. For on the hypothesis the comet is continually retrograde; the northern latitude increases up to February 20, then gradually decreases again, as the observations themselves attest. How great, moreover, the true distances of the perpendiculars running from the comet to the trace were, from the centre of the Earth and then from the intersection of the annual orbit and the trace of the trajectory, and likewise the heights of the perpendiculars themselves, is by no means hidden in the little table above; and also that these perpendiculars (which should be carefully noted) decreased steadily, regardless of the latitudes now increasing, now decreasing. Above all it is clear, and this is almost the chief point, how great the true motion in the trajectory was at every time. But was this motion entirely equal and uniform on all days? Or increasing, or rather decreasing, and up to what point was it so? That is not so readily perceived from that calculation and table. Accordingly I have derived this trajectory motion from the little table above and the calculation, in due proportion, for each single day.

[Margin: Calculi congruentia.] *The agreement of the calculation.*

[Margin: An motus verus Ccmetæ 1661 fuerit æqualis?] [recte: Cometæ] *Was the true motion of the comet of 1661 equal?*

Table N. [TABULA N.]

Showing the daily motion of the Comet of 1661. [Motum Cometæ 1661 diurnum exhibens.]

February	Daily motion	March	Daily motion
	Semid.T		Semid.T.

February	Daily motion	March	Daily motion
3	225	1	239
4	229	2	236
5	233	3	233
6	237	4	230
7	241	5	227
8	245	6	224
9	249	7	221
10	253	8	218
11	258	9	215
12	263	10	212
13	268	11	208
14	272	12	204
15	277	13	200
16	280	14	196
17	277	15	192
18	273	16	188
19	269	17	184
20	266	18	180
21	263	19	176
22	260	20	172
23	257	21	168
24	254	22	164
25	251	23	160
26	248	24	156
27	245	25	152
28	242	26	148
		27	144
		28	140
	6566		5387

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You will see that, in its trajectory motion, this comet was a very remarkable phenomenon, such as I have found none at all so far among the preceding ones

[656] The table is set differently from Tables L and M. It stands at the left of the text block with the prose running beside it on the right, as the little table of p. 874 does, and it is ruled in four columns forming two pairs side by side, February at the left and March at the right, each pair a column of days and a column of figures, the two pairs divided by a double rule. The heads are italic: the first column of each pair is headed only by the month, Febr. and Martii, and the second by Motus diurnus (daily motion); below them each second column carries the unit Semid.T (semidiameters of the Earth), printed without a point in the February pair and with one in the March pair, kept here as printed on a line of its own. The month is printed only in the heads, never beside a day. Rules cross both pairs after every fourth line of figures, and the vertical rules lean slightly to the right down the page. Below a rule at the foot each column of figures carries one more figure, 6566 and 5387, with no word or label beside it; on the two lines that carry March 27 and 28 the February pair is blank on the page. No other foot row of labels. The heading TABULA N. is set in capitals of one height, where the headings of Tables L and M on p. 873 open with a taller T.

and, besides, the two more recent ones. For first, from its very rising it was at once much swifter than all the others that have so far become known to me; for in a single day it crossed 225 semidiameters of the Earth, whereas none of the rest extended its course to 200. Second, all the others, as many as have been properly observed, either intensified their trajectory motion more and more or slackened it little by little; this one, however, continuously from the 3rd to about the middle of February made its motion more intense, up to 55 semidiameters of the Earth in the space of 24 hours, although in its apparent motion it had continuously become slower. For at the first time of its appearance the comet traversed only 225 semidiameters of the Earth in one day, but on February 16, 280 semidiameters of the Earth. Thereafter, in due proportion, with a most regular motion (not a confused and irregular one, which I would have you note, as has been found in all comets in every place), it became steadily slower again up to March 28, when in the space of 24 hours it completed only 140 semidiameters of the Earth: at which very many will marvel.

[Margin: Cometa 1661 velocior fuit in ſuâ Trajectoria, quàm reliqui omnes.] *The comet of 1661 was faster in its trajectory than all the others.*

[Margin: QuotSemid.T. uno die trajecerit?] *How many semidiameters of the Earth did it cross in one day?*

But what is the more solid reason for this, and from where does this difference take its origin? It has already been set out fully enough in Book IX, p. 687, and here and there elsewhere: namely, that this motion can in no way be entirely equal and uniform, for various causes adduced in their place in Book IX; and then, that the more the comet approaches or recedes from the perpendicular that falls from the Sun onto the trajectory (not onto the trace, which you should carefully note, since it is not the same thing, as will be said shortly), the more that motion is intensified or slackened. This has already been confirmed above with very many comets, however much this very point has not been noticed by others up to now. Since, therefore, this perpendicular from the Sun falls between the lines of sight themselves, and indeed between K and L of the preceding diagram, namely in the middle of February, it necessarily came about that the nearer the comet approached this perpendicular, the faster it was; and conversely, receding gradually thereafter, the slower it became. But if perhaps you should say that the diagram presented shows the fastest motion in quite another place than the calculation in the little table: for the perpendicular runs out between K and L, that is, about February 13, whereas the calculation moves it to February 16; and therefore the diagram and the calculation are entirely at odds with each other. But in truth, my reader, there is no

[Margin: Motus in Trajectoria nunquam in Cometis æqualis eſt.] *Motion in the trajectory is never equal in comets.*

[Margin: Cur Cometa 1661 in media fere itineris fuerit velociſſimus?] *Why was the comet of 1661 fastest about the middle of its course?*

reason why you should take the matter so strictly in this respect. For it is very easy, both in constructing the theory and in extending the true daily

motion to the individual days (especially if you do not have the observations of whatever days you need at hand), to go astray on one day or another. However that may be, you should know that this time I have deviated from the truth by scarcely a very little. For, as I touched on above, one must consider here not the perpendicular where it falls from the Sun onto the trace, but where it falls onto the trajectory. When this is well examined, since in this comet's course the perpendicular just mentioned falls at a fairly wide angle onto a trajectory running so high above the plane of the ecliptic, you will see that I have hit the mark quite exactly.

[Margin: Cometa ſemper ibi celerrimus, abi perpendiculum ex Sole in Trajectoriam incidit.] [recte: ubi] *A comet is always fastest at the place where the perpendicular from the Sun falls onto the trajectory.*

Third, it is also most worthy of notice that this comet, in respect of the fastest motion in its trajectory, was the swiftest of all the others, both earlier and later ones; whereas the same comet, in respect of its apparent motion in its orbit, was, as I was just saying, almost the slowest of all. For no comet that I have ever had occasion to examine by calculation crossed a greater space in its trajectory than 220 semidiameters of the Earth in a single day, and that near the perpendicular itself, as can be seen in the comet of 1607; but this comet of 1661, in the middle of February, flew through 280 semidiameters of the Earth, likewise in an interval of 24 hours. Perhaps you are persuaded that the comet of 1607 had by no means reached the perpendicular at that time, and therefore could not have exerted so very fast a motion either. But in my opinion, even if it had reached the right angle, that is, the angle of the trajectory and of this perpendicular proceeding from the Sun, it would still in no way have reached the speed of this comet of 1661. For comets that are equidistant from that point of the trajectory to which the perpendicular runs out are not always equally fast, as has already been shown in the Book above; rather, each always enjoys its own peculiar motion and its own proportion of speed and slowness. Nor does it matter at all in this respect whether they are equally or differently distant from the Sun, as we have likewise demonstrated.

[Margin: Cometa 1661 motu apparente fuit tardiſſimus, ſed motu vero aliorum rapidiſſimus.] *The comet of 1661 was slowest in apparent motion, but in true motion the fastest of all the others.*

[Margin: Quilibet Cometarum diverſo motui obnoxius eſt.] *Every comet is subject to a different motion.*

For it is clear from the little table set beside this that the comet, even when it was nearest, namely on February 10, was only 2529 semidiameters of the Earth away from the Sun; likewise that the comet of the year 1607, on October 25 (as can be seen on p. 693), stood off at almost as great a distance, namely 2660 semidiameters of the Earth. Nevertheless the fastest motion of the comet of 1661 was found on February 16 to be 280 semidiameters of the Earth, although that of the other was only 220 semidiameters of the Earth. So the trajectory motion by no means corresponds to the distance of the comet from the Sun. I

have chosen to set these distances down here, together with the angle of the Sun's radius and the trajectory, and also the motion of the comet from the Sun, as was done on p. 691 of the preceding Book on the occasion of the earlier comets, so that one phenomenon or another can be investigated the more easily and clearly.

	Distance of the comet from the Sun	Angle of the Sun's radius with the trajectory	Motion of the comet from the Sun	Daily motion
Febru-	Year	1661		
ary				
	Sem. T.			
3	3236	50° 3′		
			9° 42′	3° 0′
6	2872	59° 45′		
			18° 59′	5° 0′
10	2529	78° 44′		
			50° 29′	10° 0′
20	3202	50° 47′		
			21° 25′	2° 30′
March 2	5058	29° 22′		
			7° 50′	1° 0′
10	6758	21° 32′		
			6° 40′	0° 22′
28	9668	14° 52′		

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[Margin: Motus Trajectorius neutiquam reſpondet Intervallo Cometæ à Sole.] *The trajectory motion by no means corresponds to the distance of the comet from the Sun.*

Fourth, it should be noted that, although these two comets agree fairly accurately in respect of the distance of the comet from the Sun around the greatest speed, they nevertheless disagree, in turn, very evidently in respect of the motion from the Sun. For the motion of the comet of 1607 from the Sun, even where it was the fastest of all, still did not exceed 3° 40′, as is plainly clear

[657]The table has no caption of its own; the prose before it calls it the little table set beside this, and it stands at the right of the text block with the prose running beside it on the left. It is ruled in five columns. The first has no head; the others carry italic heads, given here in English as one head each. Below the heads the page prints a line with Febr. (February) in the first column, Anno (year) in the second and 1661 in the third, and then a unit line: Sem. T. (semidiameters of the Earth) over the distances, kept here as printed, and Gr.M. or Gr.Min. (degrees, minutes) over the three angle columns, written here in the house notation. The first three columns stand on the lines of the dates. The motion of the comet from the Sun and the daily motion stand half a line lower, each between two dates, six values for seven dates, and are set here on rows of their own between the dated rows, as printed. The month is printed only at February and at March 2. A rule after February 20 crosses the first three columns only; no foot row of labels.

from the table on p. 692; by contrast, this comet of 1661, as the little table above shows, had increased the same motion to 10°, although each phenomenon, as we have said, was removed by an almost equal space both from the Sun and from the perpendicular.

[Margin: Motus Cometarum ex Sole non variatur ad illorum Diſtantiam.] *The motion of comets from the Sun does not vary with their distance.*

While I was committing this to writing, it occurred to me: might there lie some cause of the most widely differing speed, at equal distances from the Sun and at the same time at equal angles of the Sun's rays with the trajectory? For since every comet holds its own peculiar track and course, however it may be directed toward the Sun, it follows that each comet too, or its trajectory, takes up a position or inclination with respect to the Sun and to the Sun's poles and equator that differs entirely from one comet to another (for, as has been discovered, the Sun too enjoys its own poles, since it rotates about its axis in a space of almost 27 days). So the trajectory of this comet inclines more nearly toward the poles, and now that of that comet more nearly toward the equator. Moreover, it is placed beyond every hazard of doubt that the Sun's motion is far more vigorous around its equator than around its poles. Therefore (if, that is, the motion of the Sun's circumgyration can contribute anything to the motion of comets, which, however, I would not yet wish to assert so firmly), all comets running out nearer to the Sun's equator would necessarily be much faster than those climbing toward the Sun's pole. I add that those comets which set their course directly according to the gyratory motion of the Sun, and are carried along a track parallel to the solar equator, are far more vigorous in trajection than those which proceed with an oblique, or even an entirely contrary, motion, that is, against the motion of the Sun. But whether the matter is so or not, I leave to the interpreters of these heavenly things to investigate. For many things in this business still lie hidden, which perhaps a late posterity will be the first to bring out into the light. We could indeed shake out this matter somewhat more deeply and more fully, namely by inquiring into the inclinations of the solar poles with respect to the Earth, and then by examining how the various courses of comets correspond to those different inclinations of the trajectories with respect to the solar poles; but, hastening to other matters, we do not think we should dwell on these any longer.

[Margin: Vnde diverſa velocitas Cometis obtingat.] *From what source comets come to have different speeds.*

[Margin: Sol quoque ſuum Æquatorem, Poloſq; poſſidet.] *The Sun too possesses its own equator and poles.*

[Margin: Quorum Cometarum Trajectio ad ductum Æquatoris Solaris incidit, fuerunt præ reliquis velociores.] *Comets whose trajection falls along the track of the solar equator were faster than the rest.*

[Margin: Habet omnis ætas, quod agat.] *Every age has something to do.*

Meanwhile we hold it settled and fixed, as we have deduced at length in the earlier Books, that each comet exerts its own peculiar motion in its trajectory,

apparent as well as true: unequal indeed, but nevertheless most regular, and, around the perpendicular falling from the Sun onto the trajectory, the fastest of all. But how far this comet carried its journey in its trajectory, or how great a space of the heaven it actually traversed; then whether this comet, like all the preceding ones, remained within the bounds of the planetary system, or whether it left it entirely: this must now be investigated, especially since in one day, or in a space of 24 hours, it crossed by its speed 280 semidiameters of the Earth, that is, 240,800 German miles, namely where it was fastest; but where slowest

[Margin: Qualem motum habeant Cometæ.] *What kind of motion comets have.*

[Margin: Quæſtiones de hoc Cometâ decidendæ.] *Questions to be decided about this comet.*

it covered at least 225 semidiameters of the Earth, or 193,500 German miles, so that it was somewhat faster than Mercury (which, according to our hypothesis, runs through only 160,204 German miles in its daily motion, as is clear from p. 703).

On pp. 704 and 715 we did indeed set out to confirm that no comet at all is slower than Saturn, or faster than Mercury, in their orbs; but this must be understood to hold only so long as the comet does not come nearer to the Sun than Mercury itself does. Since, however, others sometimes approach nearer to the Sun than Mercury, as also happened with this comet of 1661, these too can certainly be faster than Mercury. For we have learned this from the passages of so many comets: the more they approach the Sun, the swifter the course with which they are carried; yet in such a way that they almost never go out of the orbs of the planets (since there is no example whatever to the contrary), as also becomes manifest in this comet, although of all the others it was the fastest in respect of its true course in the trajectory. For from 3 February to 28 March this comet wandered through 11,953 semidiameters of the Earth in its trajection; yet this route of its journey still falls far short of being larger than the orb of Mars, not to say that of Saturn. For according to our hypothesis the diameter of the orb of Mars comes to 27,660 semidiameters of the Earth, whereas the extent of that comet's trajectory scarcely fills 12,000 semidiameters. Thus it is demonstrated again and again, by this phenomenon too, that this very phenomenon was born, and died, within the planetary system.

[Margin: Quando Cometæ etiam Mercurio ſint velociores.] *When comets are faster even than Mercury.*

[Margin: Nec hic Cometa, nec alius quisquam Syſtema Planetarum unquam egreſſus eſt.] *Neither this comet nor any other has ever gone out of the system of the planets.*

[Margin: Quantum cæli ſpatium Cometa 1661 emenſus ſit totâ duratione,] *How great a space of the heaven the comet of 1661 traversed in its whole duration.*

Indeed, even granting that this comet had been visible for a whole, entire year, and had kept up just as swift a course on the following days as on the 53

preceding days on which we observed it, that is, 11953 semidiameters of the Earth (although from day to day it was evidently slowed in its true motion), it would nevertheless have been carried no further than 81171 semidiameters of the Earth. That is, it would indeed have reached a little beyond the whole diameter of the orb of Jupiter, which is given as 66,720 semidiameters of the Earth, as we asserted on p. 713; but it would still have completed a far smaller space than the whole diameter of the orb of Saturn, that is, 114,160 German miles.

[Margin: Etiamſi hic Cometa omnium rapidisſimus extiterit; tamen nec integro anno, totum orbem Saturni trajecisſet.] *Even though this comet was the fastest of all, it would still not have crossed the whole orb of Saturn, not even in an entire year.*

In sum, to bring this book too to an end at last: in whatever way we consider the comet of 1661, so often mentioned, whether in respect of its apparent motion or of its true motion, each and every thing that we have asserted in general about all the other comets in the earlier Books can also be confirmed by this comet, so that not even a single phenomenon conflicts at all with our hypothesis. But I break off, and go on now to illustrate the two later comets and to construct their hypotheses, and also to examine the whole matter rigorously, point by point: whether by these comets too we are not unable to clarify and establish our general theory more and more?

[Margin: Quæcunque de cæteris Cometis aſſerta ſunt, ea etiam hoc Cometâ 1661 corroborantur.] *Whatever has been asserted about the other comets is also corroborated by this comet of 1661.*

Johannes Hevelius, Cometography, Book Eleven [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER UNDECIMUS.]

On the Theory of the Two More Recent Comets of 1664 and 1665 [De THEORIA Duorum Recentiorum Cometarum 1664 & 1665.]

I do indeed admit that, if we consider the order of things, it would have been much more fitting and more reasonable if, as I had proposed at the outset, I had held back until this point all and every one of the observations of both comets, that is, of those that arose in the years 1664 and 1665, together with the calculation duly derived from them, so that everything to be said and derived about them could have been placed together here, in order, before the eyes of anyone at all. But the urgings and persuasions of most honoured friends, bound to me by many close ties, whose friendship I always keep before my eyes, I judged it worth the effort to comply with, rather and more readily than with myself and my own preferences. So I wanted, as quickly as possible, shortly after the rise and departure of the earlier comet, namely at the beginning of the year 1665, to bring out a *Prodromus* on that comet.

[Margin: Quare Obſervationes Cometarum 1664 & 1665 ab autore haud fuerint adſcriptæ.] *Why the observations of the comets of 1664 and 1665 have not been set down by the author.*

In it, however, I presented only the more general features of this comet of 1664: first, namely, a general description of the observations, with genuine drawings of the head and tail; then the place and motion of the comet, determined only roughly by means of the globe, since at that time, owing to the shortness of time, it could not be done otherwise; with a short dissertation appended on the motion, generation and various phenomena of all comets; so that this little work might in this way be like a forerunner, a *Prodromus*, of this Cometography of ours.

[Margin: Prodromus non niſi generaliora Cometæ 1664 exhibet.] *The Prodromus presents only the more general features of the comet of 1664.*

But since at that very time I had learned for certain that controversies had arisen among some most distinguished men on account of my observations, I was compelled, even most unwillingly, to bring out a clarification of those matters, namely a description of the later comet, of 1665, with the *Mantissa* to the *Prodromus Cometicus*. In that little work, for very many reasons, I set before the eyes of everyone all the particular observations of both comets made by me here at Danzig with suitable instruments: not only bare, but also unravelled, that is, worked out by due and accurate calculation; from which, in turn, the genuine apparent motion, then stripped of all refraction, in very many little tables, with all tedious calculation omitted, as may be

[Margin: Cur Mantiſſa Prodromi conſcripta ſit ?] *Why the Mantissa to the Prodromus was written.*

[Margin: Deſcriptio poſterioris Cometæ, & Mantiſſa ſpeciales obſervationes exhibent.] *The Description of the later comet and the Mantissa present the particular observations.*

seen there, I derived and demonstrated with precision, so that above all the matters then in question could at once be examined, clarified and confirmed there.

Likewise, partly in the *Prodromus* and partly in the *Mantissa*, I brought out the course of both comets in various figures, of their faces as well as of their tails, with a short description of those matters appended, illustrated with notes and remarks. So it is now by no means necessary to dwell on these any longer. Nothing more therefore remains to be weighed and dealt with here than that I present and set out the theory of both comets, held back until now, in the same manner, namely, as we have done for the earlier comets: so that it may be clearly shown whether all the phenomena of these comets, no less than those of the other comets, can also be saved just as well and correctly by an almost straight trajectory; and then also that the true position and track of the trajectory may be demonstrated by lines and by calculation, so that it may be established whether the said trajectory went outside or inside the limits of the great orb, and whether it proceeded by touching it or by cutting it. Further: with what

speed it advanced in respect of its true motion in the trajectory, whether equal or unequal? Whether this motion continually increased, or rather decreased? How far it was removed from the Earth each day? Whether that intervening space between the Earth and the comet remained constantly one and the same? What track the comet kept? Whether it continually approached the Earth, or rather receded from it, and both in what manner and with what degree of speed or slowness? No less, how great the genuine parallaxes were at every time? What the angle of obliquity of the trajectory was, and also what the distance of the comet from the Sun was? And other things of this kind that bear on this.

[Margin: Hoc lib.XI. non niſi Theoria Cometæ 1664 & 1665 exponitur.] *In this Book XI only the theory of the comet of 1664 and 1665 is set out.*

[Margin: Quænam quæſtiones decidendæ ſint.] *Which questions are to be decided.*

All of this, moreover, can now be investigated far more readily in these comets than in the preceding one of 1661. For since, in the comets of 1664 and 1665, both the apparent motion (and that stripped of all refraction), namely in longitude, latitude, right ascension and declination, and the proper motion have already been found with precision for every single hour, and a complete ephemeris has thus been constructed, we can dispense with all of that here, and proceed at once to constructing the hypothesis itself and to determining the true motion and the distance from the Earth.

[Margin: Quare facilius motus verus in Cometâ 1662, quàm in Com. 1661 obtineatur ?] *Why the true motion is obtained more easily in the comet of 1662 than in the comet of 1661.*

Before we come to that, however, reason demands that we first skilfully explore, from the very first appearance up to 4 February, from the true places (entirely freed of refractions, and presented in the *Mantissa* to our *Prodromus*), the genuine parallax belonging to the comet of 1664, and so its distance from the Earth, which were held back expressly to this place. This parallax can indeed be investigated in this comet of 1664 by a different method, since the comet stayed above the horizon for quite a long time not only in the evening but also in the morning, so that with one and the same fixed star it formed entirely different positions, now vertical, now almost parallel to the horizon. Therefore, to pass over the other methods for the moment, that very method of parallactic calculation could be applied to this comet which we followed for the comet of 1652 in Book IV, as being the best of the rest, by which the parallax of altitude would at once be discovered; for not only do I have at hand suitable distances of this kind, obtained with the sextant, but the rest too, which might perhaps be wanted [deſiderarentar] [recte: deſiderarentur], could

[Margin: Parallaxis Cometæ 1664, quâ ratione explorata fuerit.] *How the parallax of the comet of 1664 was explored.*

be investigated at will, with the greatest ease, for any position of the comet whatever, from its true place freed from refractions. But this method of searching out parallaxes, however much safer it is than the others, is too laborious

and also very lengthy, as can be seen in Book IV. Therefore, so as not to abuse the reader's kindness too far and stretch these labours out further and further, I have taken a plainer and shorter way, and indeed the very one I followed for the preceding comet of 1661: namely, finding from two vertical distances the difference of parallax, that is, of different altitudes.

Since I by no means had such distances, taken with the instruments while the comet stood in one and the same vertical circle, for every desired time, it was necessary to derive them from the true place of the comet, stripped of all refraction. [Margin: Quales Diſtantiæ verticales ad parallaxes computandas adhibitæ fuerint.] *What vertical distances were used to compute the parallaxes.* To begin with, on the 15th of December I computed the comet for the parallactic calculation from the Tail of ♌; on the 18th of December from the Back of ♌; on the 31st of December and the 1st of January from the Palilicium; on the 5th and 7th of January from the left heel of Perseus; on the 10th, 17th and 21st of January, and likewise on the 2nd, 3rd and 4th of February, from Algol; that is, by the same method that we used in Book X and also on p. 47 of the *Description* of the comet of 1665. I have therefore entered the data and the results in the little table attached, where at the same time the distances both

Vertical distances of the comet of 1664 from certain fixed stars, freed from all refraction and from proper motion, with the genuine parallaxes of the comet and its distances from the Earth.

Month	Day, in the year 1664	Time, corrected, morning	Longitude of the fixed stars	Latitude of the fixed stars	Longitude of the comet	Latitude of the comet, south	Distance of the comet from the fixed stars, stripped of all refraction	Altitude of the comet	Distances freed from proper motion	Difference of the parallax of altitude	Horizontal parallax	Distance of the comet from the Earth (semidiameters of the Earth)
December	15	$4^h\ 29^m$	♍ 6° 57′ 24″	18′ B.	♍ 6° 28′ 8″	21′ 33″ A.	34′ 52″	9° 30′	39° 34′ 52‴		0′ 59″	3500
		$5^h\ 12^m$	Tail of ♌		♍ 6° 23′ 42″	23′ 39″	34′ 55″	12° 30′	from the Tail of ♌			
	18	$3^h\ 36^m$	♍ 6° 35′ 24″	20′ B.	♍ 3° 20′ 12″	24′ 36″	17′ 58″	7° 30′	47° 17′ 58‴		1′ 9″	3000
		$4^h\ 57^m$	Back of ♌		♍ 3° 18′ 6″	21′ 47″	27′ 42″	10° 30′	from the Back of ♌			
	31	$7^h\ 19^m$ *vesp*	5° 6′ 54″	♊ 31′ A.	♊ 3° 1′ 38″	♊ 11′ 58″	44′ 56″	16° 45′	28° 44′ 34″		8′ 36″	400
		$9^h\ 2^m$	Palilicium		♊ 2° 20′ 38″	14′ 48″	20′ 53″	23° 0′	from the Palilicium			*dub.*

Month	Day, in the year 1664	Time, corrected, morning	Longitude of the fixed stars	Latitude of the fixed stars	Longitude of the comet	Latitude of the comet, south	Distance of the comet from the fixed stars, stripped of all refraction	Altitude of the comet	Distances freed from proper motion	Difference of the parallax of altitude	Horizontal parallax	Distance of the comet from the Earth (semidiameters of the Earth)
	1	9h 18m *v.*	5° 6′ 54″ Palilicium	31′ A.	24° 21′ 40″	43′ 24″	26′ 50″	27° 0′	24° 26′ 46″ from the Palilicium		11′ 28″	300
		11h 44m			23° 58′ 36″	59′ 54″	6′ 10″	20° 0′				*dub.*
	5	7h 58m *v.*	26° 27′ 24″	8′ B.	8° 58′ 50″	37′ 30″	13′ 10″	38° 0′	30° 13′ 7″		1′ 22″	2500
		9h 37m	left heel of Perseus		8° 53′ 56″	33′ 42″	13′ 17″	33° 0′	from the heel of Perseus			
1665	7	8h 51m *v.*	26° 27′ 24″	8′ B.	5° 19′ 08″	17′ 36″	18′ 13″	36° 0′	29° 18′ 13″		0′ 59″	3500
		10h 6m	left foot heel of Perseus		5° 17′ 38″	11′ 32″	15′ 30″	29° 0′	from the heel of Perseus			
January	10	7h 49m *v.*	21° 31′ 24″	22′ B.	2° 4′ 18″	14′ 29″	42′ 20″	42° 0′	32° 42′ 20″		0′ 52″	4000
		9h 48m	Algol		2° 3′ 53″	07′ 7″	32° 36′ 27″	29° 0′	from Algol			
	17	7h 19m *v.*	21° 31′ 24″	22′ B.	28° 24′ 08″	52′ 23″ B.	1° 6′ 7″	44° 0′	31° 6′ 7″	0″	0′ 34″	6000
		9h 36m	Algol		28° 23′ 07″	58′ 11″ B.	1° 5′ 17″	27° 0′	from Algol			
	21	6h 45m *v.*	21° 31′ 24″	22′ B.	27° 29′ 26″	31′ 10″ B.	30° 37′ 43″	46° 0′	30° 37′ 43″		0′ 26″	8000
		9h 39m	Algol		27° 29′ 27″	33′ 43″ B.	30° 37′ 27″	26° 0′	from Algol			
February	2	6h 0m *v.*	21° 31′ 24″	22′ B.	26° 29′ 17″	18′ 24″ B.	36′ 3″	46° 0′	29° 36′ 36″		0′ 21″	10000
		6h 42m	Algol		26° 29′ 16″	32″ B.	34′ 40″	43° 0′	from Algol			
	3	6h 41m *v.*	21° 31′ 24″	22′ B.	26° 29′ 18″	24″ B.	31′ 27″	42° 0′	29° 31′ 27″		0′ 19″	11000
		8h 19m	Algol		26° 29′ 27″	14″ B.	32′ 3″	30° 0′	from Algol			
	4	7h 52m *v.*	21° 31′ 24″	22′ B.	26° 27′ 31″	27″ B.	31′ 33″	35° 0′	29° 31′ 33″		0′ 16″	12000
		10h 45m	Algol		26° 27′ 25″	38″ B.	31′ 0″	11° 0′	from Algol			

[658] freed from refraction and from all proper motion, which yield the parallax of the difference of altitude, and also the horizontal parallax and the desired distance from the Earth in semidiameters of the Earth, you will find for twelve days. I judged it unnecessary for every single day. Between the 18th and the 31st of December, indeed, when it was nearer the Earth, I would certainly have wished to work them out; but for want of observations, which because of the unkind sky were by no means obtained, I had to give up this labour. So you will be content with these parallaxes produced this time; if you want more, it will not be burdensome for you to investigate them yourself, whether in this way or in another, whichever seems better.

From this calculation it is now evidently clear that the horizontal parallax, duly derived from the genuine observations themselves, was 0′ 59″ at the beginning of the appearance, namely on the 15th of December; that thereafter it increased little by little, to nearly the end of December, to 8′ or 11′; and that afterwards it diminished again gradually up to the 4th of February, so that at the last it was no more than 16″. [Margin: Parallaxis Cometæ 1664, quanta fuerit.] *How great the parallax of the comet of 1664 was.* It is therefore an infallible argument that the comet was farther from the Earth at its beginning than around the middle of its course, and, conversely, less remote at its very exit.

For on the 15th of December, according to this calculation, the comet was 3500 semidiameters of the Earth away from us; at the end of December, however, scarcely 400 or 300 (yet nonetheless six or eighty times farther than the Moon is from the Earth); again, on the 2nd of February it was already more than 10,000, and on the 4th of February 12,000 semidiameters of the Earth away from us. [Margin: Cometa quanto intervallo à Terrâ fuerit elongatus.] *At what distance from the Earth the comet was removed.* And as these results flowed from a fitting trigonometrical calculation, so they may also be well trusted. On the 31st of December and the 1st of January, however, since the comet then had its swiftest proper motion, I do not attribute too much to those parallaxes. I am

[658] The table is printed with thirteen columns and twelve ruled rows, each row of two printed lines, set here as two table rows. One heading, Menſis Dies Anno 1664 (month, day, in the year 1664), stands over the first two columns: the month is printed vertically, reading upward, beside the day figures, Decembris beside the December rows, Januarii 1665. beside the January rows with the year at its upper end (level with 7 January), and Februarii beside the February rows; the month names are set here on the row where each begins, the year on the row it stands beside. The time column is headed Tempore correcto. Manè. (by the corrected time, in the morning), with hours, minutes and seconds; the first lines of the later rows add *vesp* (31 December) or *v.*, kept as printed. The fixed-star columns give the star's longitude and, on the first line only, its latitude, with the star's name on the second line; the comet's longitude, latitude, distance from the star and altitude are given for both times. The column of distances freed from proper motion gives one value per row, with the star it is reckoned from on the second line, and the columns of the difference of the parallax of altitude (in seconds), the horizontal parallax (in minutes and seconds) and the distance from the Earth give one value per row; under the distances of 31 December and 1 January (400 and 300) the page prints *dub.*, probably for dubium, doubtful. B. and A. are north and south.

wholly persuaded, as the calculation from the hypothesis and the diagram itself as drawn clearly show, and as the reasoning of proportion rightly requires, that the parallax on those days by no means reached 8′ or 11′, but was at most 3′ or 3½′; so that I fully believe that in its perigee, around the 29th of December, it came scarcely nearer to the Earth than 900 or 1000 semidiameters of the Earth. Of these matters, however, more will be said later at greater length. [Margin: Quot Semid. T. Cometa in Perigæo à Terr[[á/â]] diſtiterit.] *How many semidiameters of the Earth the comet stood from the Earth in its perigee.* Meanwhile it is most certain that, to whatever place you may even move the trajectory, the comet was by no means less than 4[659] or 300 semidiameters of the Earth distant from us, even in its very perigee; and so, by pressing necessity, it moved in the highest aether, against the opinion of all the Peripatetics. [Margin: Cometa 1664 in ſummo æthere extitit.] *The comet of 1664 was in the highest aether.*

I would indeed wish that one of the Peripatetics would undertake to deduce properly, by trigonometrical calculation, how both this comet and all the other comets mentioned in this work could, by sound reasoning, be freed from all the inconsistencies, indeed absurdities, as regards both their apparent motion and their true motion, in the aerial region? — just as has indeed been done by us in its proper place. [Margin: Autor nullo modo ſibi perſuadet, Peripateticos poſſe Cometas ſalvare in aëre.] *The author is by no means persuaded that the Peripatetics can save the comets in the air.* But if anyone should wish to bring forward splendid arguments resting on nothing but bare words, and with them to destroy our entire calculation utterly, that is certainly by no means permitted. For the Peripatetics must fight with us with equal weapons and arguments; that is, from certain observations, provided they are open to all, they must demonstrate everything precisely: namely, that the motion of the comet could indeed appear so very swift, and so differently at this distance from the Earth as at that, and that the comet, for the whole of its duration in time, did not leave the sublunary air, and so on. But I am fully convinced that this will never be accomplished anywhere by the Peripatetics. Therefore there is no point either in our going down into the arena with them. For they usually deny us the very principles, which are beyond all exception. [Margin: Contra principia negantes, non eſt diſputandum.] *There is no disputing with those who deny principles.* Some of them call into question parallaxes that they themselves do not know how to work out by calculation; indeed, they do not even rightly understand what parallax is, or in which category it stands. With such people I certainly have no business; as far as I am concerned, they may persist in that same opinion, however wholly at odds with reason it is. Meanwhile I shall nonetheless stand firmly by my own view, which I would not fear to demonstrate for all comets, by due calculation as well (provided sound observations are given): namely, that comets move in the highest aether, notwithstanding that sometimes, as we have shown in its place, they can also pass through the sublunary air right down

[659] The page prints 4 here, where its account of the end of December above gives 400 or 300.

to the Earth itself; until, that is, someone proves the plain contrary with more examples, in a better and safer way, by a calculation rightly set up. [Margin: Cometæ nonnunquam ipſam Terram prætervehuntur.] *Comets sometimes ride past the Earth itself.*

But leaving these matters aside, let us come to the theory itself, which we shall first construct by lines, according to our method; then, also by numbers, taking the trajectory to be nearly straight, let us set out the course of the comet. For we cannot arrive at the calculation without a diagram, unless the trajectory is first set up in a drawing at a definite angle of inclination with respect to the great orb; and this has also been done in the accompanying figure. I confess that at first this comet of 1664 (although I had observations on which I could safely rely) gave me a great deal, a very great deal, of trouble, beyond all the others presented in this work. Nevertheless, when I had put my hand to the work and correctly drawn the lines of sight in the diagram from the known elongations of the comet from the Sun, or rather from the difference of the longitudes of the comet and the Sun, I saw at once that the trace of the trajectory of this comet falls by no means inside, but outside, the bounds of the annual orbit; and indeed above the intersections of all the lines of sight up to the beginning of February, but thereafter, around the 7th, 10th and 13th of the same month, below the intersections again. So the comet, throughout its whole duration, held its course steadily outside the great orb, in which the Earth otherwise revolves, and in reality had its rising and its setting, however differently most hairy stars have taken their path. [Margin: Non fuit res ade[[ò/ó]] leviuſcula, exquiſitum Schema curſûs Cometici 1664 conſtruere.] *It was no very slight matter to construct an exact diagram of the course of the comet of 1664.* [Margin: Trajectoria hujus Cometæ extra orbem annuum,atque ſupra ſectiones incesſit.] *The trajectory of this comet went outside the annual orbit and above the intersections.*

For even if you labour with all your might to draw the trajectory below the intersections, you are nevertheless grasping at plain impossibilities, in whatever way and at whatever inclination you attempt it. Above the intersections, however, as we have said, the matter succeeds happily, namely where the perpendicular from the Sun falls on the trace, at ♋ 22° 18′, when, that is, the Earth is at X, and the trajectory makes with its trace (taken, that is, as entirely straight and not at all curved) an angle, or [?] inclination, of about 17°. [Margin: Quo loeo Eclipticæ incidat perpendiculum ex Sole ad Trajectoriam.] [recte: loco] *At what place of the ecliptic the perpendicular from the Sun to the trajectory falls.* [Margin: Inclinatio Trajectoriæ Cometæ, 1664.] *The inclination of the trajectory of the comet, 1664.* In this position, I say, the course and true motion of the comet at every time agree exactly with any phenomena whatever: above all, the distances from the Earth on all the days agree with the horizontal parallaxes, with the genuine observations themselves, and with the parallaxes, and the distances from the Earth, correctly derived from them by calculation. And yet, I would have you believe, I worked out the parallaxes from the observations far later than the theoretical calculation (however much it is placed first here).

At this I myself marvel not a little, all and each of them agreeing so precisely, even though I did not alter this diagram even once, as indeed happens fairly often in this business, but kept it in exactly the place where I marked the trace the first time: where, namely, the distance of the comet from the Earth on the 15th of December is given as 4074 semidiameters of the Earth, with the radius of the annual orbit set at 5157 semidiameters of the Earth, according, that is, to our hypothesis; or, what comes to the same thing, where the least distance of the trace from the great orb is 569 semidiameters of the Earth. [Margin: Quanto intervallo Trajectoria ab orbe magno, in minimâ remotione diſtiterit.] *At what distance the trajectory stood from the great orb at its least remoteness.* For in no other position of the trace, with respect both to the great orb and to the rays of the Sun and the lines of sight, is the distance of the true daily motion in the trajectory brought nearly to equality.

So when, in this diagram of ours, the Earth is at A, that is, on the 15th of December, the comet is seen at H; on the 18th of December, with the Earth at B, the comet is found at I; on the 21st of December, with the Earth placed at C, the comet is met with at K; and so on in order. [Margin: Dilucidatio Schematis Cometæ 1664.] *Explanation of the diagram of the comet of 1664.* And so, as the observations clearly prove, the comet has in its orbit an apparent retrograde motion, and indeed one most varied from day to day: slower, namely, at the beginning, soon swifter, swiftest on the 27th and 30th of December, when, that is, the phenomenon hangs most closely over the Earth; then slower again from day to day, and at last slowest of all. [Margin: Schema exact[[è/é]] reſpondet Obſervationibus; ſed datâ Trajectoriâ incurvatâ.] *The diagram answers exactly to the observations, but with the trajectory taken as curved.* As to its motion in the trajectory, however, the comet has it nearly equable and uniform over its whole duration, like all the preceding comets, provided, that is, you set up the trajectory bent in part, as may be seen at q M r, marked with dots. For on this curved, or as it were conic, line the perpendicular from the Sun to the trace falls not at x†[660] but at q, as the following calculation also actually shows: namely, that the true motion, right up to the exit and at the very beginning, was swiftest, as you will soon see more fully. [Margin: Pro incurvatione Trajectoriæ, aliter atq; aliter perpendiculum ex Sole incidit.] *According to the curving of the trajectory, the perpendicular from the Sun falls in one place or another.* With an entirely straight trajectory, however, this is quite otherwise, since the greatest speed seems to occur at K and x†. Right reason therefore urges most strongly that all the phenomena can be saved more fittingly in a trajectory partly curved than in one stretched out entirely straight, on the model of all the other comets. For we have already shown more than enough in Book IX that all comets, namely, accelerate their motion around the perpendicular coming out from the Sun, and show it slower the farther they are from it. [Margin: Cometæ circa perpendiculum ex Sole omnium ſunt ve[?]ociſſimi.] *Comets are swiftest [?] of*

[660] Here and in the next sentence the page prints a small x set above a small cross, a point label of the diagram, kept as printed.

all around the perpendicular from the Sun. All of this likewise happens exactly in this comet, supposing, that is, the trajectory curved in part toward the Sun.

Next, from certain observed latitudes, we set out by our method to find the inclination [?] of the trajectory; this angle of obliquity, as is clear from the diagram above [?], is about 17°, the trajectory being taken, that is, as entirely straight. So the diagram itself answers fittingly to the observed motion of the comet, since the trajectory passes almost into a straight line. But what the reason may be that the trajectory of this comet appears straighter from the observed latitudes than those of the comets of 1661 and 1665, I would hardly dare to determine as yet from so few examples. [Margin: Cur Trajectoria hujus Cometæ rectior, quàm Cometæ 1661 & 1665?] *Why is the trajectory of this comet straighter than those of the comets of 1661 and 1665?* For we must have more observations of more comets before we can decide anything certain on this matter. [Margin: Trajectoria extra, qu[[à/á]]m intra orbem annuum eſt rectior.] *The trajectory is straighter outside the annual orbit than inside it.* Meanwhile, however, I almost persuade myself that comets travelling outside the annual orbit, more di-

Diagram. The upper of the two diagrams on the plate numbered Fig. NN. It is headed, at the upper left, Theory of the comet of 1664, observed by Johannes Hevelius. The Sun, S, stands low in the middle of the plate. A fan of radii runs from it up and to the left to the arc of the Earth's annual orbit, which is lettered A to N and dated by the radii from 15 December to 13 February. Above and to the left of the orbit, lines of sight run from the orbit to the comet's trajectory, each marked with a longitude in the zodiac. The trajectory itself runs in from the upper right and out at the lower left.

- Title (upper left): Theory of the comet of 1664, observed by Johannes Hevelius.
- Longitudes written along the lines of sight, as printed: ♌ 7° 20′ (far left); ♊ 15° 8′ (written upright); ♉ 18° 58′; ♉ 8° 59′; ♉ 4° 5′; ♉ 1° 15′; ♈ 29° 29′; ♈ 28° 25′; ♈ 27° 7′; ♈ 26° 58′; ♈ 26° 28′ (the last three stacked on converging lines at the upper right); ♍ 9° 23′, ♍ 25° 11′ and ♎ 2° 23′ (at the left edge).
- Trajectoria. (along the uppermost converging line, upper right): Trajectory.
- r (alone at the right end of the converging lines).
- Linea Viſoria. (twice, along two lines of sight in the centre): Line of sight.
- A single zodiac sign on a line of sight in the centre, read as either ♉ or ♋ [?].
- P, O, N, M, L (down a line from the centre toward the left).
- A small x set over a small cross, with K to its upper right (left of centre).
- I and H (at the left, below the x-and-cross sign).
- Trajectoria (along the line running out at the lower left): Trajectory.
- A single italic letter below it, read as either q or g [?].

- A, B, C, D, E, F, G, H, I, K, L, M, N (along the orbit, from the upper right to the lower left).
- Day figures along the radii: 15, 18, 21, 24, 27, 30, 2, then the month written across the radii, December; 5, 8, 11, 14, then January; 17, 20, 23, 26, 29, 1, 4, 7, 13, then February. One radius between those marked 7 and 13 carries no figure.
- Orbis annuus Terræ. (outside the orbit, at the right): Annual orbit of the Earth.
- Eccentrica Solaris. (written upward beside the radii): Solar eccentric.
- S (where the radii meet): the Sun.
- Fig. NN (engraved to the right of the radii): the plate number.

Diagram. The lower part of the same plate (Fig. NN) holds two further constructions without a title. In the first, a nearly horizontal line across the plate is marked as the trace of the trajectory. Dotted perpendiculars fall from it, each dated, to a slanting line, the trajectory, which rises from the lower left to the upper right. In the second, at the foot of the plate, slanting lines rise from points on a base line, and dated verticals stand on the same base line.

- Middle construction, capitals above the horizontal line (left to right): H, I, K, L, M, N, O, P, Q, R, S, T, V. The dotted line dated 8 has no capital above it, and a further dotted line between those dated 11 and 17 carries neither a capital nor a figure.
- Vestigium Trajectoriæ. (below the horizontal line at its left, split by the dotted lines): Trace of the trajectory.
- Trajectoria. (along the slanting line at the left, and again at the right): Trajectory.
- Vestigium. (below the right-hand Trajectoria, along the horizontal line): Trace.
- Day figures beside the dotted lines (left to right): 15, 18, 21, 24, 27, 30, 2, 5, 8, 11, 17, 23, 29, 4.
- Lower-case letters on the slanting line (left to right): c, d, e, f, g, h, i, k, l, m, n, o, and a last letter read as either p or k [?].
- Lower construction, capitals on the base line (left to right): A, B, C, D, H, I, K, L, E, F, M, G, N, H, O, P. H appears twice. Slanting lines rise from A, B, C, D, E, F, G and H, and verticals stand on H, I, K, L, M, N, O and P.
- Day figures beside the verticals: 15, 18, 21, 24, 27, 30, 2, 5.
- Lower-case letters at the heads of the verticals: c, d, e, f, g, h, i, k.
- Engraver's line (lower right, between the two constructions): Engraved by the author.

rect a trajectory than inside it do they describe, and the farther they are removed from the Sun, the flatter the course they keep. For this reason, since this comet of 1664, among the other two of 1661 and 1665, was the more remote of them all with respect to the Sun, and also drew its course outside the annual orbit while those drew theirs inside the orbit, those could therefore not produce

so straight a trajectory. But the reason why the trajectory of comets more remote from the Sun is straighter than that of nearer ones is this: their cone, from which the course is described, is larger than that of the nearer ones; and hence the trajectory of these comets is necessarily curved far more than that of those that are farther removed from the Sun, as the learned understand well enough. [Margin: Traiectoria quò propior Solis; eò curvior eſt.] *The nearer a trajectory is to the Sun, the more curved it is.* Whether some other, stronger reason for this lies beneath it cannot at present be asserted so firmly; but for the investigators and discoverers of the hidden wonders of nature it will be easier, in the course of time, to uncover this: namely, from what source these most diverse phenomena take their origin.

Moreover, it is also clearly seen from the preceding delineation [Delineatione] that near the beginning of its appearance the comet was a morning comet, namely where the lines of sight extended toward the east up to 27 and 28 December; that in the middle, around 28 and 29 December, it made its conjunction with the Sun; and that thereafter, up to its extinction, it was an evening comet. [Margin: Vnde ex delineatione cognoſcatur, Cometā initiò matutinum, dein veſpertinum extitiſſe.] *From what in the delineation it may be recognised that the comet was at first a morning comet, then an evening one.* For the lines of sight then ran out toward the west, as could not have happened otherwise, given the contrary motion of the comet and of the Earth, and its varying position. Finally, it also becomes clear from the same figure how the comet's apparent daily motion was slowed more and more each day from 29 December, so that at the beginning of February it was found almost stationary in longitude, and afterwards direct again, as the lines of sight plainly prove. [Margin: Motus verus Cometæ 1664 in dies ſegnior eſt redditus.] *The true motion of the comet of 1664 became slower day by day.* For at first these lines of sight intersect the trajectory more obliquely and are longer, being drawn, that is, from the Earth to the comet; then they are shorter and cross the trajectory more nearly at right angles; and at the last, more obliquely again; hence they are lengthened from day to day. For this reason the apparent daily motion necessarily becomes slower at the beginning, swiftest in the middle, and slacker again at the end, indeed almost stationary, and finally retrograde. [Margin: Motus apparens in medio extitit velociſſimus, & in utra[[à/â]]q́; extremitate remiſſior.] *The apparent motion was swiftest in the middle, and slacker at either extremity.* Indeed, on 1 February the lines of sight run almost parallel to one another, which is the most evident proof that the comet was then retrograde, as we clearly showed in its place, Book IX, page 638. [Margin: Cometa in fine retrogradus.] *The comet retrograde at the end.*

Lastly, the things that remain are likewise not difficult to find out from the diagram itself with the help of the proportional compass [circini proportionum], and quite precisely at that: namely, 1 the heights of the perpendiculars falling from the comet onto the trace; 2 the distances [Diſtantiæ] of the perpendiculars

from the comet onto the trace, from the centre of the Earth; 3 the distances [Intervalla] of the comet from the Earth, and so on. [Margin: Mediante Schemate quævis explorantur facillimè.] *By means of the diagram anything at all is found out very easily.* But from the diagram I shall on this occasion enter in the attached little table only the distances of the perpendiculars, in the trace, from the centre of the Earth (since the case of the rest is the same), so that they may not be unable afterwards to be compared with the calculation and the observations.

December	Rough distances of the perpendiculars from the comet onto the trace, from the centre of the Earth, from the diagram (semidiameters of the Earth)	Distances [Intervalla] of the comet from the centre of the Earth, roughly taken from the diagram (semidiameters of the Earth)
15	3400	3650
18	2800	3000
21	2000	2300
24	1250	1600
27	800	1150
30	900	1250
2	1450	1550
5	2100	2150

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[Margin: Cometa quanto ſpatio a Ter. ra abfuit, juxta Schematis ductum.] *How far the comet was from the Earth, according to the drawing of the diagram.*

I now pass on to examining the theory itself by calculation, and to exploring all the rest: above all, how do the true motion in the trajectory, and the distance from the Earth, agree with those derived from the observations themselves? This calculation turned out for us almost still more laborious than the one for the comet of 1652 set out on page 599 of Book IX. [Margin: Calculus Cometæ 1664 fuit laborioſisſimus.] *The calculation for the comet of 1664 was most laborious.* Because the trajectory of this comet runs outside the annual orbit and nowhere intersects it, as is plain from the diagram given above, I was therefore forced to adopt an entirely different method of calculation. But there is no point in relating here how it was carried out, or is to be carried out, so that we may not detain you, kind reader, longer than is fitting. Yet whoever rightly understands the precepts on page 596, and is not ignorant of how to work out all the remaining cases properly, and is moreover well versed in trigonometrical calculation and does not spare labour, will in the end grasp this procedure correctly as well. Therefore I set before you at once the very products of the calculation in some little tables. Under the first are those

[661] This is the little table announced at the foot of the preceding page. It stands at the head of the page at the left, with the prose set in a narrower measure to its right. On the leaf the first heading is set over the day column and the first column of figures together; the day column carries only the word Decemb. at the level of the units, and the days 2 and 5 stand with no month printed against them. Both units are printed Semid. Ter. A rule divides the first four rows from the last four.

various angles deduced immediately from the known longitude of the Sun and of the comet and necessary for the rest of the calculation, together with the subtenses of the motions of the Earth in its great orb; it is followed by two other little tables setting out the genuine calculation, as you see was done for the earlier comets. [Margin: Capita calculi Tabellis quibusdam exhibentur.] *The main heads of the calculation are shown in some little tables.* The first of these latter two gives the calculation for a trajectory, or trace, H K M O Q that is entirely straight; the second, however, gives the calculation with the trajectory, or trace, taken as curved in part, along the line q M r. [Margin: Calculus tam juxta rectam, quàm incurvatam Trajectoriam initus eſt.] *The calculation was undertaken for a straight as well as for a curved trajectory.*

Calculation for the theory of the comet seen in 1664 and 1665.

Little table showing the various angles which are deduced immediately from the known longitude of the Sun and of the comet, and are required for the rest of the calculation, together with the subtenses of the motions of the Earth in its great orb.

Day	Observed longitude of the comet	Observed latitude of the comet	Motion of the comet from the intersection X, that is, 11 January	True longitude of the Sun	Motion of the Earth from X, or 11 January	Complements of half the motion of the Earth	Elongation of the comet from the Sun, or difference of longitude	Angles of the lines of sight with the subtenses of the motions of the Earth	Angles of the trajectory with the subtenses of the motions of the Earth	Complements of these angles	Subtenses of the motion of the Earth (semidiameters of the Earth)
X	3ˢ 22° 18′			9ˢ 22° 18′			90° 0′				
December 15	6ˢ 5° 50′	22° 55′ *A.*	16° 28′	8ˢ 24° 43′	37° 35′	76° 13′	78° 53′	2° 40′	13° 47′	166° 13′	2459
18	6ˢ 2° 23′	26° 16′	19° 55′	8ˢ 27° 47′	4° 32′	77° 44′	85° 23′	7° 39′	12° 16′	167° 44′	2191
21	5ˢ 25° 13′	30° 58′	27° 7′	9ˢ 0° 51′	21° 27′	79° 16′	95° 40′	16° 24′	10° 44′	169° 16′	1920
24	5ˢ 9° 23′	37° 21′ *A.*	42° 55′	9ˢ 3° 55′	18° 23′	80° 49′	114° 32′	33° 43′	9° 11′	170° 49′	1651
27	4ˢ 7° 20′	38° 29′	74° 58′	9ˢ 6° 59′	5° 19′	82° 21′	149° 39′	67° 18′	7° 39′	172° 21′	1368
30	2ˢ 13° 8′	39° 38′	50° 50′	9ˢ 10° 3′	2° 15′	83° 52′	153° 5′	69° 13′	6° 8′	173° 52′	1100
January 2	1ˢ 18° 58′	32° 33′ *A.*	26° 40′	9ˢ 13° 7′	9° 11′	85° 25′	125° 51′	40° 26′	4° 35′	175° 25′	825
5	1ˢ 8° 59′	12° 37′	16° 41′	9ˢ 16° 10′	16° 8′	86° 56′	112° 49′	25° 53′	3° 4′	176° 56′	552
11	1ˢ 1° 15′	3° 21′	8° 57′	9ˢ 22° 18′	0° 0′	90° 0′	98° 57′	8° 57′	0° 0′	180° 0′	0
17	0ˢ 28° 25′	25° 52′ *B.*	6° 7′	9ˢ 28° 25′	5′	86° 58′	90° 0′	3° 2′	3° 2′	176° 58′	547
23	0ˢ 27° 7′	7° 7′	4° 49′	10ˢ 4° 32′	14′	83° 53′	82° 35′	1° 18′	6° 7′	173° 53′	1099
29	0ˢ 26° 3′	18° 39′	4° 20′	10ˢ 10° 38′	20′	80° 50′	76° 0′	4° 50′	9° 10′	170° 50′	1643
February 4	0ˢ 26° 3′	38° 28′ *B.*	4° 10′	10ˢ 16° 44′	25′	77° 48′	69° 45′	8° 3′	12° 12′	167° 48′	2181

Day	Observed longitude of the comet	Observed latitude of the comet	Motion of the comet from the intersection X, that is, 11 January	True longitude of the Sun	Motion of the Earth from X, or 11 January	Complements of half the motion of the Earth	Elongation of the comet from the Sun, or difference of longitude	Angles of the lines of sight with the subtenses of the motions of the Earth	Angles of the trajectory with the subtenses of the motions of the Earth	Complements of these angles	Subtenses of the motion of the Earth (semidiameters of the Earth)
			x†HA		XSA	SXA	SAH	XAH	AXH		XA
			x†IB		XSB	SXB	SBI	XBI	BXI		XB
			x†KC		XSC	SXC	SCK	XCK	CXK		XC

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Table showing the main heads of the calculation for the comet of 1664 and 1665.

At 9^h in the evening of the current day	Observed longitude of the comet	Observed latitude of the comet	Longitude of the comet deduced from the hypothesis	Latitude of the comet deduced from the hypothesis	True longitude of the Sun	Elongation of the comet from the Sun, or difference of the longitudes	Angle of the trace of the trajectory with the lines of sight of the comet's longitudes
December 15	5° 50′ ♎	22° 55′ *A.*		22° 55′ *A.*	24° 34′ ♐	SAH 78° 53′	x†HA 16° 28′
18	2° 23′	26° 16′	2° 19′ ♎	26° 14′	27° 47′	SBI 85° 23′	x†IB 19° 55′
21	25° 11′ ♍	30° 58′	25° 26′ ♍	30° 55′	0° 51′ ♑	SCK 95° 40′	XKC 27° 7′
24	9° 23′	37° 21′ *A.*	9° 21′ ♍	37° 20′ *A.*	3° 55′ ♑	SDL 114° 32′	XLD 42° 55′
27	7° 20′ ♌	48° 29′	7° 18′ ♌	48° 29′	6° 59′	SEM 149° 39′	XME 74° 58′
30	13° 8′ ♊	39° 38′	13° 8′ ♊	39° 38′	10° 3′	SFN 153° 5′	XNF 50° 50′
January 2	18° 58′ ♉	22° 33′ *A.*	18° 57′ ♉	22° 33′ *A.*	13° 7′ ♑	SGO 125° 51′	XOG 26° 40′
5	8° 59′	12° 37′	8° 58′	12° 36′	16° 10′	SHP 112° 51′	XPH 16° 41′
11	1° 15′	3° 21′	1° 15′	3° 21′	22° 18′	SIQ 98° 57′	XQI 8° 57′
17	28° 25′ ♈	0° 52′ *B.*	28° 25′ ♈	0° 52′ *B.*	28° 25′ ♑	SKR 90° 0′	XRK 6° 7′
23	27° 7′	3° 7′	27° 9′	3° 8′	4° 32′ ♒	SLS 82° 35′	XSL 4° 49′

[662] The first column has no heading on the leaf; its months are printed once each, the December label split over the rows of the 15th and the 18th, January beside the 2nd and February beside the 4th, and the first row carries only the capital X. The longitudes are printed in signs, degrees and minutes; the latitudes carry *A.* or *B.*, south or north, against the first row of a group only. The last three rows are labels of points of the figure, printed under the columns as shown, below the row of 4 February; x† stands for a small x set over a small cross. The second figure of the tenth column's value for 21 December is a 0, with a short stray hook below it at the right. In the heading of the eleventh column the last word is printed with a t for the u (-ortm.) [recte: angulorum]; its first letter does not separate a from æ. Rules divide the rows after X, after the 21st and the 30th of December, after 11 January and after the 29th.

At 9^h in the evening of the current day	Observed longitude of the comet	Observed latitude of the comet	Longitude of the comet deduced from the hypothesis	Latitude of the comet deduced from the hypothesis	True longitude of the Sun	Elongation of the comet from the Sun, or difference of the longitudes	Angle of the trace of the trajectory with the lines of sight of the comet's longitudes
29	26° 38′	4° 39′	26° 38′	4° 39′	10° 38′	SMT 76° 0′	XTM 4° 20′
February 4	26° 28′ ♈	5° 28′ *B.*	26° 24′ ♈	5° 28′	16° 43′ ♒	SNV 69° 45′	XVN 4° 10′

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[663] The first column's heading gives the hour of reckoning; its months are printed once each, beside the 15th of December, the 2nd of January and the 4th of February. The longitudes are printed in degrees and minutes with the sign of the zodiac set only where a group opens or the sign changes; the latitudes carry *A.* or *B.*, south or north, against some rows only, and the latitude deduced for 4 February carries none where the observed latitude has *B.* The cell for the deduced longitude of 15 December is blank. In the last two columns each value is preceded by the letters of the points of the figure that name the angle; x† stands for a small x set over a small cross; the label for 21 December in the last column opens with a capital X and no cross. Rules divide the rows after the 21st and the 30th of December and after the 11th and the 29th of January.

[664] Tested against the large table on the preceding page, reported only. The observed longitudes and latitudes agree with it in all thirteen rows. The Sun's longitudes agree in twelve; for 15 December this table prints 24° 34′ ♐ where the preceding page prints 8^s 24° 43′. The elongations agree in twelve; for 5 January this table prints 112° 51′ where the preceding page prints 112° 49′. The difference of the printed longitudes of the comet and the Sun gives the printed elongation to the minute in eleven rows; it gives 85° 24′ for 18 December against 85° 23′, 78° 44′ for 15 December against 78° 53′ (the Sun's longitude of the preceding page gives 78° 53′), and 112° 49′ for 5 January against 112° 51′. The last column agrees in all thirteen rows with the motion of the comet from the intersection X on the preceding page, and its first two labels and the first three labels of the elongation column agree with the label rows there; the third label of the last column is printed x†KC there and XKC here. The deduced longitudes differ from the observed by at most 15′ (21 December) and the deduced latitudes by at most 3′ (21 December). This table, like the preceding page, prints 13° 8′ ♊ for 30 December and 26° 38′ ♈ for 29 January, where the plate of Fig. NN has 15° 8′ ♊ and 26° 58′ ♈.

Day	Motion of the Earth from the perpendicular drawn from the Sun to the trajectory	Angle of the lines of sight with the subtenses of the motion of the Earth	Subtenses of the motion of the Earth from that point X (semidiameters of the Earth)	Distance of the perpendicular from the comet onto the trace of the trajectory, from the centre of the Earth (semidiameters of the Earth)	Distance of the same perpendicular from x† (semidiameters of the Earth)	Height of the same perpendicular (semidiameters of the Earth)	True motion of the comet over the days in the trajectory (semidiameters of the Earth)	Distance [Intervallum] of the comet from the centre of the Earth (semidiameters of the Earth)	Angle of obliquity of the trajectory from the straight line
December 15	XSA 27° 35′	XAH 2° 40′	XA 2459	AH 4074	x†H 1520	Hc 1978	cd 1012	Ac 4529	37° 0′
18	XSB 24° 32′	XBI 7° 39′	XB 2191	BI 3034	x†I 712	Id 1369	de 794	Bd 3384	
21	XSC 21° 27′	XCK 16° 24′	XC 1920	CK 2172	x†K 80	Ke 1303	ef 752	Ce 2533	29° 38′
24	XSD 18° 23′	XDL 33° 43′	XD 1651	DL 1220	x†L 734	Lf 931	fg 430	Df 1534	18° 45′
27	XSE 15° 19′	XEM 67° 18′	XE 1368	EM 777	x†M 1160	Mg 878	gh 513	Eg 1172	16° 38′
30	XSF 12° 15′	XFN 69° 13′	XF 1100	FN 882	x†N 1652	Nh 731	hi 454	Fh 1114	16° 33′
January 2	XSG 9° 11′	XGO 40° 26′	XG 825	GO 1410	x†O 2082	Oi 585	ik 477	Gi 1526	14° 27′
5	XSH 6° 8′	XHP 25° 23′	XH 552	HP 2081	x†P 2544	Pk 466	kl 1098	Hk 2132	13° 16′
11	XSI 0° 0′	XIQ 8° 57′	X 0	IQ 3657	x†Q 3613	Ql 214	lm 1438	Il 3664	12° 0′
17	XSK 6° 5′	XKR 3° 2′	XK 547	KR 5605	x†R 5022	Rm 85	mn 1937	Km 5606	12° 53′
23	XSL 12° 14′	XLS 1° 18′	XL 1099	LS 9919	x†S 7021	Sn 542	no 2320	Ln 9931	8° 43′ *dub.*
29	XSM 18° 20′	XMT 4° 50′	XM 1643	MT 10984	x†T 9315	To 894	op 2837	Mo 11020	19° 39′
February 4	XSN 24° 25′	XNV 8° 3′	XN 2181	NV 14168	x†V 11986	Vp 1848		Np 19404	

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Table showing the main heads of the calculation for the comet of 1664 and 1665, with the trajectory given as curved.

At 9[h] in the evening of the current day	Distance of the perpendicular from the comet onto the trace of the trajectory, from the centre of the Earth (semidiameters of the Earth)	Distance of the perpendiculars from one another (semidiameters of the Earth)	Height of the same perpendicular (semidiameters of the Earth)	True motion of the comet over 3 days in the trajectory (semidiameters of the Earth)	Distance [Intervallum] of the comet from the centre of the Earth (semidiameters of the Earth)	Horizontal parallax (minutes, seconds)	Angle of the trajectory, or of the trace, with the straight line: angle of obliquity (degrees, minutes)
December 15	AH 3300		Hc 1602		Ac 3669	0′ 57″	30° 42′
18	BI 2630	HI 512	Id 1298	cd 595	Bd 2933	1′ 10″	16° 51′
21	CK 1910	IK 502	Ke 1146	de 524	Ce 2227	1′ 35″	22° 30′
24	DL 1235	KL 490	Lf 943	ef 530	Df 1554	2′ 13″	
27	EM 777	LM 480	Mg 878	fg 484	Eg 1172	2′ 57″	17° 22′

[665] The first column has no heading on the leaf. Its month names, Decembris, Januarii and Febr., are set sideways beside the days, reading upward, and are given here against the first day of each month. Each value except those of the last column is preceded by the letters of the points of the figure that name it; x† stands for an x set over a small cross, and the same sign closes the heading of the sixth column. The fourth column for 11 January carries the label X alone and the figure 0. The eighth column is blank on the last row, and the last column on the second and the last rows. The value of the last column for 23 January is followed by the abbreviation dub., three italic letters and a point, which marks the value as doubtful. The last letter of Cometæ in the eighth column's heading is heavily inked and does not separate a from æ; the sense is not affected. Rules divide the rows after the 21st and the 30th of December and after the 11th and the 29th of January.

[666] Tested against the large table on the preceding page and among its own columns, reported only. The second column agrees in all thirteen rows with the motion of the Earth from X on the preceding page, and the fourth with the subtenses of the motion of the Earth there; their first three labels agree with the label rows there. The third column agrees in twelve rows with the angles of the lines of sight with the subtenses on the preceding page; for 5 January it prints 25° 23′ where the preceding page prints 25° 53′, which is also the elongation less the complement of half the Earth's motion on that page (112° 49′ less 86° 56′). The fifth column's first value, 4074, agrees with the figure for 15 December on p. 884. Against the little table on the preceding page, the fifth column's first eight values (4074 to 2081) stand beside its rough distances of the perpendiculars (3400 to 2100), and the ninth column's (4529 to 2132) beside its rough distances (3650 to 2150); the least value of the fifth column is 777 on 27 December and of the ninth 1114 on 30 December. The square root of the sum of the squares of the fifth and seventh columns agrees with the ninth column to within 1 in nine rows; it gives 3329 for 18 December against 3384, 1146 for 30 December against 1114, 9934 for 23 January against 9931, and 14288 for 4 February against 19404. No triangle on this page prints all three of its angles.

At 9^h in the evening of the current day	Distance of the perpendicular from the comet onto the trace of the trajectory, from the centre of the Earth (semidiameters of the Earth)	Distance of the perpendiculars from one another (semidiameters of the Earth)	Height of the same perpendicular (semidiameters of the Earth)	True motion of the comet over 3 days in the trajectory (semidiameters of the Earth)	Distance [Intervallum] of the comet from the centre of the Earth (semidiameters of the Earth)	Horizontal parallax (minutes, seconds)	Angle of the trajectory, or of the trace, with the straight line: angle of obliquity (degrees, minutes)
30	FN 882	MN 470	Nh 731	gh 492	Fh 1114	3′ 6″	17° 37′
January 2	GO 1410	NO 460	Oi 58[?]	hi 482	Gi 1526	2′ 15″	15° 8′
5	HP 2081	OP 450	Pk 466	ik 456	Hk 2132	1′ 38″	16° 20′
11	IQ 3610	PQ 860	Ql 211	kl 896	Il 3613	0′ 58″	18° 45′
17	KR 4900	QR 840	Rm 74	lm 887	Km 4900	0′ 42″	18° 6′
23	LS 6290	RS 820	Sn 342	mn 862	Ln 6299	0′ 33″	19° 47′
29	MT 7735	ST 800	To 630	no 851	Mo 7760	0′ 27″	18° 8′
February 4	NV 9076	TV 780	Vp 869	op 768	Np 9118	0′ 23″	
February 13	10880				10962	0′ 20″	

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[667]The table is laid out like the lower table of the preceding page, with eight columns in place of ten and fourteen rows in place of thirteen: the last row, for 13 February, has no counterpart there and carries values only in the second, sixth and seventh columns, without point letters. The heading of the first column gives the hour of reckoning; the month December is printed above the first day, in the row of units, and January and February beside the 2nd, the 4th and the 13th. Each value in the second to sixth columns is preceded by the letters of the points of the figure that name it; the distances between the perpendiculars (third column) and the motions (fifth column) begin on the second row. The seventh column gives minutes and seconds, the eighth degrees and minutes. Blank on the leaf: the third and fifth columns on the first row, the eighth column for 24 December, 4 February and 13 February, and the third, fourth and fifth columns for 13 February. Rules divide the rows after the 21st and the 30th of December, after the 11th of January and after the 4th of February, so that 17, 23 and 29 January and 4 February stand in one group. The fifth column's heading says 3 days, though from 11 January the rows are six days apart. The height for 2 January is printed 58, set one figure-place left of the column's right edge; a third figure stands faint and unread in the units place.

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From the calculation of the preceding table, which sets out the course and position of the comet at intervals of three days, from 15 December to 4 February, following the drawing of the diagram above, it is first evident that the longitudes, and the latitudes as well, from the hypothesis correspond exactly to the observed ones. But it was necessary to attend carefully, for each day, to the variation of the angle of obliquity of the trajectory. [Margin: Ex variatione anguli obliquitatis certo concluditur, Trajectoriam esſe partim obliquam.] *From the variation of the angle of obliquity it is concluded with certainty that the trajectory is partly oblique.* For if I had used a constant angle of inclination, namely 17 degrees, as found from the diagram, assuming the trace to be perfectly straight, I would never, believe me, have deduced the latitudes properly and correctly from the calculation. Hence it is clearly established that the trajectory was in fact partly curved, as the variation of that angle, shown under the last column of the table above, also plainly confirms. Next, to pass over the rest, you will see how everything stood according to our hypothesis, in semidiameters of

[668] Tested against the lower table of the preceding page and among its own columns, reported only. Against the preceding page: the second column agrees in four rows (777, 882, 1410, 2081, for 27 and 30 December and 2 and 5 January), the fourth in three (878, 731, 466), and the sixth in four (1172, 1114, 1526, 2132); for 2 January the preceding page prints the height 585 where this table prints 58. The square root of the sum of the squares of the second and fourth columns agrees with the sixth to within 1 in ten rows; it gives 1146 for 30 December against 1114 (as on the preceding page), 1411 for 2 January against 1526 (the height 585 of the preceding page would give 1526), and 3616 for 11 January against 3613. The motion in the fifth column, taken as the hypotenuse of the distance between the perpendiculars beside it and the difference of the two heights it joins, agrees to within 1 for cd, de, ef, fg, gh, kl, mn and no; hi agrees only with the height 585 for 2 January (483 against 482, where 58 gives 815); lm agrees only if the heights 211 and 74 are added rather than subtracted (887 against 887); ik gives 465 against 456; and op, 768, is less than the distance 780 beside it, so that no height closes it. The angle in the eighth column, as the angle whose tangent is the difference of the heights over the distance between the perpendiculars, agrees to within 1′ for cd, de, ef, gh, hi (with the height 585), lm, mn and no, each angle standing one row above the motion it belongs to; for ik it gives 14° 49′ against 15° 8′, for kl 16° 31′ against 16° 20′, for op 17° 2′ against 18° 8′, and the angle of fg (7° 43′) is not printed, its row (24 December) being blank. The horizontal parallax, as 206265″ divided by the distance in the sixth column, agrees to within 1.5″ in thirteen rows and gives 1′ 33″ for 21 December against 1′ 35″. The third column falls by 10 or 12 a row from 512 to 450 and by 20 a row from 860 to 780.

[669] The column numbers in the prose below (12th, 14th, 15th, 16th) answer to the columns of the two tables of the preceding page counted together, the eight columns of the upper table and then the lower table's columns without its column of days: the 12th is the distance of the perpendicular from the centre of the Earth, the 14th the height, the 15th the true motion and the 16th the distance of the comet. The page reference 762 is the page carrying the little table of rough distances read from the diagram. The prose speaks of the calculation of the preceding table as founded on a perfectly straight trajectory; the title of this page's table gives its trajectory as curved.

the Earth: from the 12th column, namely, the distance of the perpendicular from the comet onto the trace, from the centre of the Earth; from the 14th column, the heights of the perpendiculars; from the 15th column, the true motion in the trajectory; from the 16th column, the true distance [Intervallum]. [Margin: Calculus cum Iconiſmo egregie conſentit.] *The calculation agrees excellently with the figure.* If you now compare these numbers with those derived above, on p. 762, roughly from the diagram with the help of the proportional compass, you will see that, although this calculation is founded on a perfectly straight trajectory, while those numbers from the diagram rest on a partly curved trajectory, they nevertheless hardly differ from one another at all.

But everything comes out still more exactly, both the true motion in the trajectory and the distance of the comet from the Earth, in the attached table and its calculation, which has a curved trajectory and a varying angle of obliquity. [Margin: Suppoſitâ Trajectoriâ inflexâ, univerſa adhuc exactiùs conveniunt.] *When a bent trajectory is assumed, everything agrees still more exactly.* For not only does this calculation agree more exactly with those numbers derived roughly from the diagram, but above all with the distance of the comet from the Earth, and with the parallaxes — the horizontal ones — as is entirely plain from the little table set out on p. 757. For around the beginning and the end almost no discrepancy at all is found. Around the middle of the path, it is true, namely at the end of December, the calculation from the hypothesis yields a distance from the Earth somewhat greater, and a horizontal parallax smaller, than the calculation from the observations themselves. But, as we have already touched on above, I do not attribute too much to that calculation for 31 December and 1 January, since the proper motion on which the calculation rests was very fast at that time; the proportion of the calculation would then suggest an almost different parallax.

[Margin: Intervalla Cometæ 1664, ex Schemate & Calculo,cum illis ex obſervationibus conferuntur.] *The distances of the comet of 1664 from the diagram and from the calculation are compared with those from the observations.* Thus on 15 December the comet was 3669 semidiameters of the Earth away from the Earth, according, namely, to the later calculation; but according to the calculation from the observations, p. 757, 3500, so that scarcely any difference stands between them. [Margin: Parallaxis exiſtente Cometâ in Perigæo.] *The parallax when the comet is at perigee.* When the comet was nearest the Earth, namely on 29 December, it was about 1100 semidiameters of the Earth away, and on 4 February 9118; hence the horizontal parallax around the end of December came to scarcely more than 3′ 6″, as we had already suspected above. [Margin: Parallaxes ex Schemate rectè reſpondent iisdem ex [?]ſervationibus & calculo.] *The parallaxes from the diagram correspond properly to the same from the [?]observations and the calculation.* For the rest, you will, I think, wonder with me not a little that the distance for any day whatever, taken mechanically with the compass from the diagram on p. 762, also comes so close to our later calculation, as the observations themselves also do. Indeed, on 15 December the distance from the

Earth according to the diagram was 3650 semidiameters of the Earth; in the table of the parallax above, on p. 757, this same distance is 3500 semidiameters of the Earth. Again, on 5 January the distance found from the diagram is 2150 semidiameters of the Earth, but from the observations 2500. From this it may plainly be gathered that you can rely quite safely even on the bare diagram (especially if you shrink from undertaking that very lengthy and almost tedious calculation, or do not know it), and then that this hypothesis rests on a solid foundation and is by no means to be rejected, as will be said somewhat more fully below.

Motion in the curved trajectory.

Day	Motion	Day	Motion
December 15		January 10	147 *S. T.*
16	198 *S. T.*	11	146
17	194	12	146
18	1 190	13	145
19	186	14	145
20	183	15	144
21	180	16	144
22	177	17	143
23	4	18	143
24	171	19	142
25	168	20	142
26	166	21	141
27	164	22	141
28	162	23	140
29	160	24	140
30	158	25	139
31	156	26	139
January 1	154	27	138
2	152	28	137
3	151	29	137
4	150	30	136
5	149	31	136
6	149	February 1	135
7	148	2	135
8	148	3	134
9	147	4	134

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[Margin: Motus Cometæ 1664 in Trajectoriâ diurnus.] *The daily motion of the comet of 1664 in the trajectory.* Finally, as regards the true daily motion in the trajectory, I wished to derive it in due proportion for each and every day of the apparition according to the later calculation, namely with the trajectory given as curved, where the latitudes and distances answer the observations more precisely, and to enter it in the attached little table. The motion of this comet, however, differs not a little from the motion of the comet of 1661. For at first it was much slower; then from beginning to end it decreases gradually and steadily, almost after the example of the comet of 1618, as regards, namely, its daily motion in the trajectory. [Margin: Cur motus verus hujus Cometæ fuit velocisſimus ?] *Why the true motion of this comet was very fast.* But that the motion of this comet of 1664 was very fast from its very beginning, and in the course of time gradu- ally slower, comes about from this, as has already been impressed rather often in the case of the other comets: at the beginning of its apparition (as can be seen in the comet of 1618, and on p. 686) the comet was nearer to the perpendicular falling from the Sun onto the trajectory, but as it went on it moved continually farther away from that perpendicular.

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670 On the leaf this table stands below its title to the right of the narrow prose that closes the paragraph above and fills the paragraph below. It is printed as two blocks side by side, each of a column of days and a column of values, with no column headings; the headings Day and Motion are given here for orientation only. The months are printed once each, beside the 15th of December, the 1st and the 10th of January and the 1st of February. The unit *S. T.* (semidiameters of the Earth) is printed after the first value of each block. The value for 15 December is blank. For 18 December a lone 1 stands at the left of the cell, apart from 190. For 23 December only a 4 is printed, in the place of the last figure, the first two places being blank. In the value for 5 January the last figure is a 9, crossed at its right by a short stray stroke. Rules divide the rows of both blocks after the 6th, 12th, 18th and 24th rows. Tested against the true motion over three days in the table on p. 890, reported only: the printed daily values for 16–18 December sum to 582 (taking the lone 1 apart) against 595 there; 19–21 December 549 against 524; 25–27 December 498 against 484; 28–30 December 480 against 492; 31 December to 2 January 462 against 482; 6–11 January 885 against 896; 12–17 January 867 against 887; 18–23 January 849 against 862; 24–29 January 830 against 851; 30 January to 4 February 810 against 768. Within the table the values fall by 0 to 4 a day, except where the 18 December and 23 December cells stand as printed.

671 Tested against the tables of pp. 889 and 890, reported only. The distance of 3669 for 15 December agrees with the sixth column of the table on p. 890 (Ac 3669); the table on p. 889 gives 4529. The 9118 for 4 February agrees with p. 890 (Np 9118); p. 889 gives 19404. Neither table has a row for 29 December, given here as the day of least distance with about 1100; their least value is 1114, on 30 December. The horizontal parallax of 3′ 6″ agrees with that of 30 December on p. 890. The distances of 3650 for 15 December and 2150 for 5 January from the diagram agree with the first and last of the rough distances of the comet on p. 888 (p. 762) as tested on p. 889. The values of p. 757 (3500 and 2500) are not on these pages and were not tested.

Accordingly the motion is slowed quite gradually, as the lines of sight have cut the trace more and more obliquely, or at a more acute angle.

[Margin: Niſi ſtatuas incurvatam Trajectoriam, nec motus verus, nec perpendiculum ex Sole rectè derivatur.] *Unless you posit a curved trajectory, neither the true motion nor the perpendicular from the Sun is derived correctly.* For the rest, this motion also seems to corroborate the hypothesis of this comet, and especially its bent trajectory line. For if you suppose the trajectory entirely straight, the perpendicular falls in a quite different place, at K, between the lines of sight, and so the motion would certainly have been more sluggish at the beginning, fastest at K, and thereafter slower again, as is plain from the diagram and as actually happened in the comet of 1661. But the whole calculation in both tables proves the exact opposite most evidently: namely, that the true motion was fastest right from the outset, on 15 December, and afterwards became gradually slower. The same is demonstrated to the eye in exactly the same way on the curved trajectory q M r. For there the perpendicular falls by no means at K, but at q, before the line of sight, namely that of 15 December, onto the ray of the Sun, namely that of 26 January. Consequently, as the calculation demands, the motion in the trajectory necessarily decreases successively, right from its very beginning to the end, in due and consistent proportion. Since this argument is likewise confirmed in all the other comets, it seems to tell remarkably in favour of the curved trajectory.

[Margin: Quantum fuerit intervallum Cometæ 1664 à Sole.] *How great the distance of the comet of 1664 from the Sun was.* How great the angle of the Sun's ray with the trajectory was, and how far this comet stood from the Sun, is evident from the attached little table: namely, that for almost its whole duration it stood farther off than the comet of 1661. For it never came nearer the Sun than 6000 semidiameters of the Earth. Conversely, the motion of the comet of 1664 as seen from the Sun was found to be slower than that of the comet of 1661, since the former was farther from the Sun than the latter.

In the year 1664	Distance [Intervallum] of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory (degrees, minutes)	Motion of the comet from the Sun (degrees, minutes)
December 15	5924	75° 8′	
			7° 47′
18	5730	82° 55′	
			7° 53′
21	5643	89° 11′	
			6° 30′
24	5771	82° 42′	
			5° 9′
27	5847	78° 33′	
			4° 38′
30	5961	73° 55′	

In the year 1664	Distance [Intervallum] of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory (degrees, minutes)	Motion of the comet from the Sun (degrees, minutes)
			3° 54′
January 2	6093	70° 1′	
			3° 37′
5	6272	66° 4′	
			6° 20′
11	6770	57° 45′	
			6° 0′
17	7065	54° 30′	
			5° 20′
23	7270	50° 0′	
			4° 30′
29	7630	48° 0′	
			4° 0′
Febru-ary 4	7900	46° 0′	

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[672] On the leaf this table stands to the right of the narrow prose that runs from the paragraph above into the one below; it carries no title of its own, and it is given here at the end of the paragraph that announces it. It has four ruled columns. The first column's heading is the year, 1664; the month December is printed in the row of units, January beside the 2nd and February beside the 4th. The motions of the last column are printed at mid-height between the two days each one joins, twelve values for thirteen days; here each stands in a row of its own between those days. From 5 January the days are six days apart instead of three. In the distance for 11 January the last figure is a 0, with an ink speck in its counter and a short stray tail below it. The word for the comet in the headings of the second and fourth columns ends in æ. Rules divide the rows of the first three columns after 24 December, 5 January and 29 January; the last column runs on without a rule.

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[Margin: Singulus Cometa, ſingularem perpetuò ſervat curſum.] *Each comet always keeps its own particular course.* Finally, as regards the position of the trajectory, you should know that it was entirely different from that of all the other comets. For hardly ever is the trajectory of one comet, as to position and course, entirely similar to that of another, as we have often pointed out. The trajectory of the preceding comet, of 1661, ran above the trace, or the plane of the ecliptic, throughout its whole apparition, since its latitudes were always northern. But the trajectory of this comet, since its latitudes were southern at first and northern afterwards, was of necessity carried below the plane of the ecliptic, or the trace, from the beginning, on 15 December, to 16 January, and thereafter above it in turn; yet in such a way that at the outset, on 15 December, the heights of the perpendiculars falling, or rather rising, from the trajectory to the trace were the greatest of all, and then, in the course of time, gradually diminished up to 16 January, and consequently to the middle of February increased again, keeping a suitable proportion, as is clear from the preceding delineation itself. [Margin: Alia prors[[ù/u]]s eſt ratio perpendiculorum, ex Trajectoriâ ad planum Eclipticæ, quàm Latitudinum.] *The reckoning of the perpendiculars from the trajectory to the plane of the ecliptic is entirely different from that of the latitudes.* Therefore the reckoning of the heights of the perpendiculars is entirely different from that of the latitudes themselves. For if the heights of the perpendiculars had to correspond strictly to the latitudes, then on 29 December, when the latitude was the greatest of all, nearly 49°, the perpendicular would necessarily also have been the longest; yet the very opposite happened. For on that day it was no more than 800 semidiameters of the Earth, whereas on 15 December, with a latitude of only 22 or 23°, it had nonetheless grown at that time to 1600. That is, although the latitude on 27 December was observed to be twice as great as on 15 December, it was nevertheless in reality half as great. This will indeed seem remarkable to more than one person; but it is

673 Tested against the prose and against the tables of pp. 889–891, reported only. The prose says the comet never came nearer the Sun than 6000 semidiameters of the Earth; the second column prints six values under 6000, from 15 to 30 December, the least 5643 on 21 December. The greatest angle of the Sun's ray with the trajectory, 89° 11′, also stands on 21 December; the prose places the foot of the perpendicular from the Sun on the curved trajectory at q, before the line of sight of 15 December. In the last column the motion from 18 to 21 December, 7° 53′, is greater than the first, 7° 47′; the values then fall to 3° 37′ between 2 and 5 January, and the six-day values from 5 January run from 6° 20′ to 4° 0′. The prose statements agree with the earlier tables as follows: the true motion fastest from the outset with the daily motion on p. 891, whose greatest value is the first, 198 on 16 December; the heights of the perpendiculars greatest on 15 December and diminishing towards 16 January with the heights on p. 890 (1602 on 15 December, least 74 on 17 January) and on p. 889 (1978, least 85 on 17 January); the latitudes southern at first and northern afterwards with the upper table of p. 889 (south through 11 January, north from 17 January). The points K, q, M and r cited in the prose stand on the plate of Fig. NN as reported for p. 885, where the letter cited as q does not separate q from g. Page 686 and the comets of 1618 and 1661 were not checked.

plain that everything truly stands so, just as the natural sequence of this matter also wholly demands. Where this itself takes its origin could indeed easily be shown: namely, that it derives from the varying position and distance of the comet from the Earth, as the learned can readily understand. But since present occupations do not allow it to be set out more clearly for novices, it is better that we hasten to the end with this comet.

[Margin: An Cometæ à plano Eclipticæ remotiores, exhibeant maximas Latitudines.] *Whether comets more remote from the plane of the ecliptic display the greatest latitudes.* It must be carefully noted, however, concerning the heights of the perpendiculars, that the comets which have the larger latitudes are not the most remote of all from the plane of the ecliptic, or the most elevated. For sometimes those comets that have far narrower latitudes move much higher or deeper above or below the plane of the ecliptic. This is made firm and settled not only by all the older comets but also by the three more recent ones. For although the comet of 1664 had a latitude of about 49° on a certain day, the height of its perpendicular nevertheless grew to no more than 1600 semidiameters of the Earth; by contrast, the preceding comet, of 1661, whose latitude was observed to be only 26°, had a perpendicular that was in reality 4000 semidiameters of the Earth. No less, the length of the perpendicular of the following comet, of 1665 (its latitude being 27°), was found to be in reality 1600 semidiameters of the Earth.

[Margin: Et Cometa 1664 paret omninò noſtræ Theoriæ.] *The comet of 1664, too, entirely obeys our theory.* These, then, are the things we had to say and point out concerning this comet of 1664 and its hypothesis. In sum, my Astrophile, you find abundantly that what is exceedingly marvellous in other comets also [?], both as to orbit and as to apparent motion, not to speak of other phenomena, can be subjected to the laws of this theory of ours, and indeed without any resistance, as both the diagram and the calculation amply show.

[Margin: Cometa 1665.] *The comet of 1665.* I now proceed to the later comet of 1665, seen in the month of April. Its observations, a good many of them, were happily acquired by us here in Danzig; we have already given them in the *Description* of this comet and investigated them by rigorous calculation. From this its apparent motion, longitude, latitude, right ascension and declination, likewise its proper motion, the angle of the orbit and the node became known to us more than sufficiently; no less its parallaxes and its distances from the Earth. And so, since a delineation of the course of its path, as well as of the head and tail, was displayed there at the same time, as may be seen in its place in a long series, nothing more seems to remain concerning this comet than that we construct its hypothesis and bring its true motion in the trajectory, as well as its distance from the Earth, according to our theory, to li- ght. All of this is now obtained the more easily, the more precisely the apparent place of the comet, freed of all refraction, has already been determined. I do not, however, wish to rehash here everything already brought to light in its place, but only to add here what will appear to bear on the theory.

[Margin: Schema hypotheſeos Cometæ 1665.] *Diagram of the hypothesis of the comet of 1665.* The diagram itself has been drawn for every second day, namely from 6 to 20 April, and indeed by exactly the same method as the earlier ones. In it, likewise, S stands for the Sun, and A C F H X for the annual orbit of the Earth. The lines from the Sun to the annual orbit are the solar rays, which determine the daily motion from the subtenses of the Earth; the lines running out from the places of the Earth A B C etc. to H I K are the lines of sight to the comet and to the trace X H K P. [Margin: Veſtigium hujus Cometæ ſupra ſectiones viſoriarum & intra orbəm annuum incedit.] [recte: orbem] *The trace of this comet runs above the intersections of the lines of sight and within the annual orbit.* In the course of this comet the trace is drawn only above the intersections of the lines of sight, because below them no place agreeing with the observations and the phenomena is to be had anywhere at all. [Margin: Quo lcco veſtigium Traject. orbem interſecet annuum.] [recte: Quo loco] *At what place the trace of the trajectory cuts the annual orbit.* The trace of this comet therefore falls within the annual orbit, in such a way that it cuts the orbit at X, namely in 20° 48′ of Scorpio, and the longitude of the trajectory is 22° 41′ of Taurus, the Earth, that is, being at X. [Margin: Angulus obliquitatis.] *The angle of obliquity.* The trajectory therefore proceeds almost straight towards the Sun, at an angle of obliquity of the trajectory with the plane of the ecliptic of only 2° 30′; that is, on a course almost parallel with respect to the plane of the ecliptic, namely on the northern side, but with respect to the great orb in the order of the signs. In this position of the trajectory the daily distances travelled, such as H I, I K, K L etc., likewise turn out nearly equal, as in the other comets. Nearly equal, I say: for, strictly speaking, as will also be clear from the calculation that follows, they grow somewhat as it proceeds. [Margin: Motus verus in dies invaleſcit.] *The true motion grows from day to day.* The reason lies in the fact that the true motion of this comet in the trajectory increased from day to day. For not only did it direct its course more and more towards the Sun as time went on, but it also came closer and closer to the Sun from day to day; and, most important of all, it kept advancing continually towards the perpendicular falling from the Sun onto the trajectory between O and P. Of this, however, more fully below.

[Margin: Curſus Cometæ 1665, à reliquorum Cometarum curſu plane diverſus eſt.] *The course of the comet of 1665 is quite different from the course of the other comets.* The course and passage of this comet is therefore quite different, if you look at those of the other comets, above all as regards the position of the trace. As regards the inclination of the trajectory, however, this comet corresponds quite closely to the comet of Regiomontanus of 1472 and the comet of Apian of 1531, since in these comets too the said angle was no more than 3°. I did indeed make every effort to bring the trajectory of this comet of 1665 nearer to the Earth, and along a different progression; but I attempted it in vain. Whether, however, the distances of the comet from the Earth in this diagram agree in this way entirely with the parallaxes derived from the calculation will

soon become clear. [Margin: Motus apparens juxta Theoriam ſequitur ipſis obſervationibus.] *The apparent motion according to the theory follows the observations themselves.* As to the apparent motion, at any rate, everything turns out consistently: for the comet was direct as long as it shone, and its apparent daily motion, as the visual rays show, decreases continually and becomes gradually slower. For the said lines of sight diverge more at the beginning than at the end, notwithstanding that the true motion in the trajectory increased by no small amount each day. For the distances between the lines of sight on the trajectory, such as H I, I K, K L etc., gradually lengthen. The latitudes, however, in our accompanying delineation also remain northern for the whole duration, and indeed decreasing, just as the observations fully confirm. Likewise the comet too, according to

Diagram. A full-page engraved plate, numbered Fig. Oo., holding the theory diagram of the comet of 1665 described on p. 894. It is headed Theory of the comet of 1665, observed by Johannes Hevelius. In the upper part, lines of sight run up from the Earth's annual orbit to the comet's trajectory, each marked at its upper end with a longitude in the zodiac; capital letters and day figures stand along the construction. The annual orbit is lettered A to H and dated 6 to 20 April. In the lower part, dotted verticals, each dated, stand on a base line lettered P to H, and lower-case letters mark a further trajectory line.

- Title (head of the plate): Theory of the comet of 1665, observed by Johannes Hevelius.
- Longitudes engraved upward along the upper ends of the lines of sight, as printed: ♉ 1° 18′; ♈ 27° 3′; ♈ 22° 10′; ♈ 16° 29′; ♈ 9° 42′; ♈ 1° 59′; ♓ 23° 29′; ♓ 14° 21′.
- Trajectoria. (upper left): Trajectory.
- Capitals and day figures of the upper construction, as read: P, 18, S, 16, 20, O, 14, N, 12, M, L, 10, K, 8, I, 6, H. S is the letter which p. 894 assigns to the Sun.
- Linea Viſoria. (twice, along two lines of sight): Line of sight.
- Trajectoria. (at the right): Trajectory.
- Linea Eccentrica Longitudinis Solaris.: Eccentric line of the solar longitude.
- ♎ (on the Earth's orbit, at the left edge of the plate).
- Orbis Annuus Terræ (along the orbit): Annual orbit of the Earth.
- Day figures on the orbit: 6, 8, 10, 12, 14, 16, 18, 20, with April. (the month): April.
- A, B, C, D, E, F, G, H (the points of the orbit).
- X.
- Trajectoria. (lower construction): Trajectory.
- Lower-case letters of the lower construction, as read: k, i, a letter read as h [?], g, f, e, d, c.
- Day figures on the dotted verticals of the lower construction (left to right): 20, 18, 16, 14, 12, 10, 8, 6.

- Capitals below the base line (left to right): P, O, N, M, L, K, I, H.
- Vestigium Trajectoriæ. (below the base line): Trace of the trajectory.
- Engraver's line (lower right): Engraved by the author.
- Fig. Oo. (lower left): the plate number.

our hypothesis, was much nearer the Earth at the beginning than at the end, as the genuine parallaxes on page 50 of the *Description* of this comet no less demonstrate, and by no means obscurely. [Margin: Cometa 1665 ab initioTerræ propior fuit, quam in fine.] *The comet of 1665 was nearer the Earth at the beginning than at the end.*

Now let us examine and investigate the theory scrupulously by calculation, but let us deliberately leave out all its figures, so that it does not become a burden to the reader. Accordingly, as we did in the two preceding ones, let us record only the data and the results in certain tables; anyone for whom these are not enough will be able to bring everything back to the anvil afresh himself. [Margin: Tabellæ calculum exhibent.] *The little tables show the calculation.* The first table, then, shows all the angles together with the subtenses of the Earth themselves; the second shows everything else that bears on the theory.

Table showing the various angles of the comet of 1665. [Tabula exhibens varios angulos Cometæ 1665.]

At 3^h in the morning of the current day	Observed longitude of the comet	Observed latitude of the comet	Motion of the comet from X	Eccentric longitude of the Sun	Motion of the Earth	Complements of half the motion	Elongation of the comet from the Sun, or difference of the longitudes of the comet and the Sun	Angle of the lines of sight with the subtenses of the Earth's motion	Angle of the trajectory with the subtenses of the Earth	Complements of these angles	Subtenses of the Earth's motion (semidiameters of the Earth)
April 6	11ˢ 14° 2′	26° 30′ *B.*	68° 20′	0ˢ 14° 48′	36° 0′	72° 0′	30° 27′	41° 33′	70° 7′	109° 53′	3187
8	11ˢ 23° 29′	29° 49′	59° 12′	0ˢ 16° 46′	34° 2′	72° 59′	23° 17′	49° 42′	71° 6′	108° 54′	3018
10	0ˢ 1° 59′	24° 37′	50° 42′	0ˢ 18° 43′	32° 4′	73° 58′	16° 45′	57° 13′	72° 5′	107° 55′	2849
12	0ˢ 9° 42′	22° 48′	42° 59′	0ˢ 20° 39′	30° 5′	74° 57′	11° 1′	63° 56′	73° 4′	106° 56′	2676
14	0ˢ 16° 29′	20° 45′	36° 12′	0ˢ 22° 34′	28° 7′	75° 56′	6° 12′	69° 44′	74° 3′	105° 57′	2505
16	0ˢ 22° 18′	18° 27′	30° 31′	0ˢ 24° 30′	26° 9′	76° 55′	2° 29′	74° 26′	75° 2′	104° 58′	2333
18	0ˢ 27° 3′	15° 56′	25° 38′	0ˢ 26° 25′	24° 10′	77° 55′	0° 25′	78° 20′	76° 2′	103° 58′	2159
20	1ˢ 1° 18′	13° 14′	21° 23′	0ˢ 28° 20′	22° 12′	78° 54′	2° 42′	81° 36′	77° 1′	102° 59′	1985
X	1ˢ 22° 41′			1ˢ 20° 48′	0° 0′	0° 0′	1° 53′ SLX				
			AHX BIX CKX		XSA XSB XSC	SXA SXB SXC	SAH SBI SCK	XAH XBI XCK	AXH BX I CXK		XA XB XC

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Table showing the main heads of the calculation for the comet of 1665.
[Tabula Calculi Capita exhibens Cometæ 1665.]

At the third hour in the morning of the current day (April)	Observed longitude of the comet	Observed latitude of the comet	Longitude of the comet deduced from the hypothesis	Latitude of the comet deduced from the hypothesis	Distance of the perpendicular from the comet onto the trace of the trajectory, from the centre of the Earth (semidiameters of the Earth)	Distance of the same perpendicular from the intersection of the annual orbit and the trace of the trajectory (semidiameters of the Earth)	Height of the same perpendicular (semidiameters of the Earth)	True daily motion of the comet in the trajectory (semidiameters of the Earth)	Distance of the comet from the centre of the Earth (semidiameters of the Earth)	Angle of obliquity of the trajectory, or [?] of the trace, from the straight line	Horizontal parallax
6	14° 21′ ♓	6° 30′ *B.*	14° 22′ ♓	6° 30′	AH 3225	XH 2275	Hc 1608½	cd 382	Ac 3603	0° 7′	58″
8	23° 29′	25° 49′	23° 29′	25° 48′	BI 3324	XI 2680	Id 1608	de 405	Bd 3693	0° 10′	57″
10	1° 59′ ♈	24° 37′	1° 59′ ♈	24° 34′	CK 3503	XK 3095	Ke 1605	ef 432	Ce 3853	0° 25′	55″
12	9° 42′ ♈	22° 48′ *B.*	9° 42′ ♈	22° 47′	DL 3755	XL 3526	Lf 1578	fg 453	Df 4073	3° 35′	52″
14	16° 29′	20° 45′	16° 29′	20° 47′	EM 4078	XM 3979	Mg 1545	gh 462	Eg 4361	3° 55′	49″
16	22° 10′	18° 27′	22° 10′	18° 11′	FN 4439	XN 4426	Nh 1480	hi 472	Fh 4679	8° 17′	46″
18	27° 3′ ♉	5° 56′ *B.*	27° 3′ ♉	5° 54′	GO 4843	XO 4888	Oi 1383	ik 515	Gi 5037	11° 23′	41″
20	1° 18′ ♊	13° 14′	1° 18′ ♊	13° 16′	HP 5305	XP 5386	Pk 1251		Hk 5450	14° 51′	38″

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[674] The printed table has a row of units at the foot of its column heads (signs, degrees and minutes; degrees and minutes; semidiameters of the Earth for the last column), carried here in the notation of the cells and in the last column head. Body rows are grouped in pairs by printed rules, then the row X, then a row of the triangles to which the columns refer, three to a cell, as printed; blank cells are blank on the page. *B.* is northern latitude, printed on the first row only. In the row X the elongation cell carries the letters SLX under the value.

[675] The printed table has a row of units at the foot of its column heads (April. in the first column; degrees, minutes and sign; degrees and minutes; semidiameters of the Earth; seconds for the parallax), carried here in the notation of the cells and in the column heads. Rows are grouped by printed rules: 6, 8 and 10 April; 12, 14 and 16; 18 and 20. The sign of the zodiac and *B.* (northern) stand only where printed. Each distance in columns 6 to 10 is preceded by the two letters of the line it measures, as printed. The daily motion for 20 April is blank on the page. In the head of the column for the angle of obliquity, a single long s stands between the abbreviations for trajectory and trace; it is taken as the abbreviation for or, with a doubt mark.

From this calculation it is clearly shown that our hypothesis is entirely fitting, and that the position of the trajectory is soundly founded. For the longitude of the comet deduced from the hypothesis for each day agrees to a hair with the observed one, that is, in the very minutes; no less does the latitude, which now and then differs by scarcely 1′ or 2′. [Margin: Etiam ex calculo Cometæ hypotheſis Autoris ſtabilitur.] *The author's hypothesis of the comet is also confirmed by the calculation.* But in this comet too it was necessary to attend carefully to the variation of the angle of obliquity, since the trajectory itself, especially toward the end, really does bend somewhat. And so I did not use that constant angle of inclination of 2° 30′, but the one set under the last little column, which on April 6 was barely 7′, while on the 20th it had already grown to 15°. [Margin: Evidentisſima variatio anguli obliquitatis.] *A most evident variation of the angle of obliquity.* Had it been done otherwise, the latitudes from the hypothesis [hxpotheſi] [recte: hypotheſi] would never have answered exactly to the observed ones. From this it is established again and again that the trajectory of this comet too was in fact partly curved, and indeed toward the Sun and the plane of the ecliptic, as can be understood, and not obscurely, from the preceding diagram. [Margin: Trajectoria Cometæ 1665 pariter eſt obliqua.] *The trajectory of the comet of 1665 is likewise oblique.* From the 6th to the 12th and 15th of April the trajectory does proceed almost in a straight line, but in the last days it turns aside very evidently from the straight line, toward the Sun and the trace.

But you may ask where this deviation comes from, and then why this trajectory is not curved uniformly in all comets. [Margin: Cur Trajectoriæ incurvatio in omnibus Cometis non ſit eadem?] *Why the curving of the trajectory is not the same in all comets.* The chief reason is that the distance from the Sun is not the same at all times; and above all, that the angle of the Sun's ray with the trajectory varies in one comet and another, now more, now less, and by different degrees of speed and slowness from the beginning right to the end, and consequently the inclination of the disc also varies, that is, the angle of the cometary disc with the trajectory, as was set out at length in Book IX, especially on page 672 and following. Hence it can in no way happen that comets are able to run their course in a perfectly straight trajectory. For since the angle of the Sun's ray with the trajectory varies exceedingly in these three as well, just as it does in every single comet (as is clear on page 691), and is almost never unchanging, the angle of the cometary disc with the trajectory, or the inclination of the disc, is consequently also constantly changing, though in an almost contrary way: namely, when the former becomes the smallest of all, the latter becomes almost the largest of all; and then, for the most part, the greatest deviation of the others arises, or the greatest inclination of the disc; and consequently at that time and in that place the trajectory turns as obliquely as it can. [Margin: Quando & ubiTrajectoria ſe ſe maximè inflectat.] *When and where the trajectory bends most. For the most part*, I say: that is, this happens in those comets which make their way crosswise between the Sun

and the Earth. But in those which take their course almost straight from the Earth to the Sun, or conversely from the Sun toward the Earth, as we found in the comet of 1665, whose trajectory's intersection X fell not far from the Earth, so that the comet passed straight to the Sun S, although in a position raised fairly high above the plane of the ecliptic, to about 1500 semidiameters of the Earth: in comets of this kind, I say, that rule is not without exception. [Margin: In quibusdam Cometis alia eſt ratio incurvationis Trajectoriæ.] *In some comets the account of the curving of the trajectory is different.* For the greatest curving of the trajectory is met with at the time when the angle of the Sun's ray with the trajectory is greatest (which became known to us at last from all the earlier comets investigated by calculation), because the greatest variation of both angles, of the Sun's ray with the trajectory as well as of the cometary disc with the trajectory, does not always, at the place where the said angles are found to be either greatest or least, oc- cur, but at the place where the greatest diversity in the angle of the disc arises; and this can come about in various places, by reason of the position of the comet and of the Sun. Accordingly, since in this comet of 1665 this greatest variation of the disc arose around its last appearance, and changed very rapidly near the Sun, the greatest bending of the trajectory therefore really does occur there too. Indeed, as is clear from the following table, the angle of the Sun's ray with the trajectory grew from 29° to almost 78°. [Margin: Variatio anguli obliquitatis in Cometâ 1665.] *The variation of the angle of obliquity in the comet of 1665.* If more observations of comets were at hand, and we wished to weigh this matter somewhat more deeply, other reasons would no doubt still be found why this phenomenon comes forth in one way and that one in another, at this time or at that. But all that could not be uncovered on this occasion, in so very abstruse a matter, let it be left to posterity, which in time, as I am fully convinced, will bring far greater things to light. [Margin: Tempus omnia magis magisq́; detegit,] *Time uncovers all things more and more.* For my part, I am now content to have worked through, from our hypothesis and with solid reasons, the most diverse phenomena and very many questions about comets that until now had scarcely been touched even lightly; so that (unless my judgement deceives me) hardly anyone can any longer deny that this theory of ours, set out in this work, is not so very inept, let alone utterly absurd.

As for the rest, how great the distance of the perpendiculars from the Earth was, and also the perpendiculars themselves and the distances of the comet from the centre of the Earth, is likewise clear from the calculation above. We notice, moreover, that the comet was 3603 semidiameters of the Earth away from us at the beginning, but 5450 at the end; that is, it was farther from us at the last than at the first. [Margin: Quanto ſpatio Cometa 1665, tam initiò, quàm ultimò àTerrâ fuerit remotus.] *How far the comet of 1665 was from the Earth, both at the beginning and at the end.* From this it is certain that this comet was already dwelling in the orb of Mercury from the first sighting, and remained in it as long as it was seen, so that on April 20 it reached only the middle of the orb of Mars, or the distance

of the Sun (as we have already said on page 50 of the *Description* of this comet). [Margin: Cometa ad Solem usque pervenit.] *The comet reached all the way to the Sun.* But whether these distances from the Sun too, drawn from the calculation, agree entirely with the distances deduced from the parallaxes on page 50 of the *Description* of this comet must now be examined. For this reason let us set out in a separate little table both the distance found from the observations themselves on page 50 of the said booklet and the distance drawn from the theory and the diagram, together with the corresponding horizontal parallaxes; from it anyone will readily be able to form his own judgement on the matter. I am truly amazed that the hypothesis answers the observations so exquisitely as regards the parallaxes. [Margin: Schema,Calculus & obſervationes Cometæ 1665 apprimè concordant.] *The diagram, the calculation and the observations of the comet of 1665 agree very closely.*

April	Distance from the Earth from the observations (semidiameters of the Earth)	Horizontal parallax	Distance from the Earth according to the theory (semidiameters of the Earth)	Horizontal parallax	Distance from the Earth from the diagram (semidiameters of the Earth)	Horizontal parallax
6	3000	69″	3603	58″	3700	56″
8	3250	67″	3693	57″	3800	55″
10	3750	57″	3853	55″	3900	54″
12	4000	52″	4073	52″	4150	51″
14			4361	49″	4500	47″
16			4679	46″	4800	43″
18			5037	41″	5200	39″
20	5000	41″	5450	38″	5600	36″

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Moreover, whether the proper motion in the trajectory was equal or unequal is likewise established from the calculation above and from its little table. At the beginning the comet covered 382 semidiameters of the Earth, and at the end 515, in a space of 48 hours. [Margin: Motus verus continuò increvit.] *The true motion increased continually.* From this it may be gathered that its motion increased continually, and indeed by almost 69 semidiameters of the Earth in 18 days, so that at the last it covered 253 semidiameters of the Earth in a single day; conversely, the motion of the earlier comet, in an inter- val of 51 days, decreased by 64 semidiameters of the Earth. In this respect these comets are almost diametrically opposed, although at the beginning each comet showed almost equal speed. The reason for this difference is this: this comet of 1665

[676] The table carries no printed heading. Each column head ends with its unit (semidiameters of the Earth for the distances, seconds for the parallaxes), carried here in the column heads and in the notation of the cells. The rules that divide the third and fourth columns and the fifth and sixth are double on the page, setting the observed, theoretical and diagram values apart in pairs. A rule runs under the row for April 12. The observed distance and its parallax are blank on the page for April 14, 16 and 18.

continually directed its course toward the perpendicular from the Sun to the trajectory, which falls between 18 and 20 April; the other, by contrast, with an entirely contrary motion, steadily moved away from the perpendicular, which was situated at 15 December. Hence the motion of the former increased, while that of the latter diminished. In what proportion it did so on each day, however, you will perceive from the little table set alongside; and from the other you will perceive the distances of the comet from the Sun, then the angle of the Sun's ray with the trajectory, and the motion of the comet from the Sun; so that you may weigh and investigate all the phenomena of this comet too, each and every one, together with those of the preceding comets, the more clearly. [Margin: Quanto intervallo Cometa à Sole abfuerit, & quo motu reſpectu Solis incesſerit.] *At what distance the comet stood from the Sun, and with what motion it advanced with respect to the Sun.*

1665, April	Daily motion of the comet of 1665	
6	181	184
7	186	189
8	191	194
9	196	199
10	202	205
11	209	212
12	216	219
13	221	224
14	227	229
15	229	232
16	231	235
17	233	238
18	236	241
19	242	246
20	250	253

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1665, April	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
6	3287	29° 21′	
			3° 55′
8	2932	33° 16′	
			5° 50′
10	2601	38° 6′	
			6° 7′
12	2263	44° 13′	

[677] This table and the next stand side by side on the page, with no printed heading. The column head for the daily motion is printed once across the second and third columns, which carry no separate heads; no unit is printed. Rows are grouped by printed rules: 6 to 9 April, 10 to 13, 14 to 16, 17 to 20.

1665, April	Distance of the comet from the Sun (semidiameters of the Earth)	Angle of the Sun's ray with the trajectory	Motion of the comet from the Sun
			8° 30′
14	1942	52° 43′	
			10° 41′
16	1655	63° 21′	
			13° 51′
18	1418	77° 15′	
20	1280	77° 39′	

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Further, it would not be out of place now also to bring forward something about the appearance and tail of this comet; but since genuine delineations of those things have already been given in the *Description* of this comet, I do not think it necessary. Yet for the sake of a greater elucidation of our theory, especially of those matters set out in Book VII on the origin and passing away, the growth and decline of comets, we have drawn from life (namely in the same Table F, page 415, in which the appearances of the comets of 1618 and 1652 are otherwise represented) the diversity of these three more recent comets too, which they presented almost every day; so that in this way you may have at a single glance the alterations of five different comets, and their growths and declines, as it was possible to observe them, namely with our telescope. [Margin: Delineatione quâdam exhibentur trium recentiorum Cometarum diverſitates facierum.] *The diversities of the appearances of the three more recent comets are shown in a certain delineation.* Before these three later comets had shone forth, I had indeed intended to sketch in the same table only the comets of 1618, 1652 and 1661, together with two fictitious ones. But since these two later ones came into view in the meantime, and those delineations had not yet been engraved on copper, I deliberately changed my plan, so that I now give the diversity of the comet of 1661 under a single line only, that of 1664 under two lines, and under the last line the alteration of the head of the comet of 1665, as was also done on page 415, to which I refer back. You will find abundantly that whatever has been said and asserted here and there in this work about the origin and passing away of comets, and about their various phenomena, rightly applies no less to these three more recent comets as well. [Margin: Qvicquid de ortu & interitu Cometarum ab Autore aſſerta ſunt, abundè tres recentiores Cometæ ſtabiliunt.] *Whatever has been asserted by the author about the origin and passing away of comets, the three more recent comets abundantly confirm.* Further-

[678] The printed table has a row of units at the foot of its column heads (semidiameters of the Earth; degrees and minutes for the last two columns), carried here in the column head and in the notation of the cells. The motions of the last column are set between the lines of the dates, each standing between two successive dates, as given here; none stands between 18 and 20 April. A printed rule runs under the row for April 12 in the first three columns. Below the table the column rules run on to a second closing rule, enclosing an empty band.

more, that none of these five comets observed with the telescope was entirely similar to any other, as regards growth, as regards decrease, the variations of its spots and the changes of its appearances; but that each of them continually had its own particular alteration and change; then that each had its own fixed time in which it grew, stood as it were in its flower, and then decreased again: as not only the observations of the comet of 1618 carefully made by Cysat, but also the observations of the comets of 1652, 1661 and 1664 show more than sufficiently. [Margin: Quot Cometæ, tot diverſæ facies deprehenduntur.] *As many comets, so many different appearances are found.* I do not deny, indeed, that throughout all those 14 days on which it shone we found the appearance of the comet of 1665 almost stable and invariable, so far, indeed, as it was possible to notice with our telescope. [Margin: Cometa 1665 ferè invariabilem vultum totâ duratione exhibuit.] *The comet of 1665 showed an almost invariable face for its whole duration.* For I am convinced that at that time this comet was in its vigorous constitution and disposition, and in its fullest flower; hence, since it had perhaps received from nature a coarser or more viscous matter than the others, it was therefore able to keep itself in almost the same state for longer than the rest. Yet I by no means doubt that, in the same way as the others at their beginning, if it had fallen to us to see it at that time, it would have shown an appearance quite different as regards its spots and their variations; and no less so if the opportunity of seeing it had been given around its very passing away; so that in the end, just as it was at first fused together from different parts, it would at the last have gone off again into the most diverse parts, after the example above all of the comets of 1618 and 1664. But let it suffice that I have touched on these things briefly, since they have already been discussed at length in Book VIII. [Margin: Quilibet Cometa, ex mente Autoris, tandem faciem immutat.] *Every comet, in the author's view, changes its appearance in the end.*

It remains for us to present here too, briefly, the true magnitudes of the heads, or diameters, of these three later comets, found by due calculation; for until now this could not yet be done, neither in the *Prodromus* nor in the *Mantissa*, for want of the parallaxes and of the distances from the Earth. [Margin: Veræ magnitudines Diametrorum trium recentiorum.] *The true magnitudes of the diameters of the three more recent comets.* Now, however, with all of these known, it is no laborious matter to find the true magnitudes of the diameters by the method given on page 334 of Book VI. [Margin: Recentiorum Cometarum apparens atq; vera Diameter diverſis in remotionibus.] *The apparent and true diameter of the more recent comets at different distances.* Therefore, leaving out, however, all the calculation, let us set down in a little table both the apparent and the true diameter of each comet for different days, so that it may be seen what kind of discrepancy there is between the diameters of these comets and of the earlier ones: whether they kept an equal true magnitude at all times, or an unequal one? and likewise whether they grew, or rather decreased?

then in what ratio, etc.: whether in a continuous rational one, or rather in an interrupted irrational one?

Magnitude of the Diameters of the Comet of 1661.

Feb.	Apparent diameter of the inner nucleus (seconds)	Distance of the comet from the Earth (*S.T.*)	True diameter in German miles	True diameter in semidiameters of the Earth and miles
3	18	2000	155	
17	30	4000	482	
Dec.	**Total diameter of the head (seconds)**	**Comet**	**1664.**	
14	12	3500	10500	12 *S.T.* 180 *Mill.*
18	15	3000	11239	13 59
21	18	2200	9914	11 54
28	22	1800	9907	11 447
29	24	1100	6603	7 *S.T.* 583 *M.*
Jan. 6	8	2300	4608	5 308
Feb. 4	3	10000	7482	8 662
April	**Total diameter of the nucleus (seconds)**	**Comet**	**1665.**	
8	12	3250	168	
16	14	4600	257	

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From this it is clear that the diameter of the inner nucleus of the comet of 1661, with all the more diluted matter adhering to it removed, was 155 German miles on 3 Feb., but 482 miles on 17 Feb.; so that there can be no doubt that its true magnitude really increased. In the comet of 1664, by contrast, when its apparent diameter is taken together with all the more diluted matter surrounding it, its true diameter grows enormously. For at the beginning it was almost six times greater than the Earth's diameter; then indeed it decreased little by little up to 6 January; nevertheless it was still larger than the Earth's diameter three times over and somewhat more. [Margin: Magnitudo capitis in Cometá 1664, quantò fuerit Terrâ amplior.] *The magnitude of the head in the comet of 1664:*

679 The table stands beside the last twenty lines of the text above, with its two-line caption over it. It falls into three sections, one for each comet, divided by double rules; each section has its own header row (set here in bold for the second and third), in which the first column gives only the month, and in the second and third sections the words Comet and 1664. or 1665. stand in the third and fourth columns as one label across them, while the second column carries a new head and the fifth column is empty. The units printed in the heads (Sec., S.T., in mill. German.) are carried in the column heads here. The fifth column is blank in the rows of the comets of 1661 and 1665; in the rows of 1664 each cell carries a number of semidiameters of the Earth and a number of miles, the units printed only in the first rows of the two groups (S.T. and Mill., S.T. and M.), kept as printed. A single rule runs across the table under 29 December. No year is printed beside the dates of January and February in the 1664 section.

how much larger it was than the Earth. Afterwards it increased again up to 4 Feb.: for on that day the true diameter of the comet was four times and more greater than the Earth's diameter. The true magnitude of the inner nucleus of the later comet, on the other hand, was 168 German miles on 8 April, and 257 on 16 April.

Here you should note carefully that in the earlier comet both the apparent and the true diameter, although its distance from the Earth continually increased, nevertheless likewise continually grew and widened; but that in the following comet, although its distance from the Earth decreased steadily and most evidently up to 29 December, the true diameter nevertheless by no means increased (as indeed it really should have been, if the body of comets were eternal: for such a body must absolutely keep one and the same magnitude for ever, as we said and demonstrated in the little book on the comet of 1665, page 55), but decreased to about 5 semidiameters of the Earth; afterwards, although its distance from the Earth was increasing, it became larger again by about 1 semidiameter of the Earth. This is entirely contrary to sound reason, if, that is, you hold that the cometary body keeps of itself a constant and invariable true magnitude. [Margin: Variatio Diametrorum Cometicorum evincit, Cometas minimè esse corpora æterna.] *The variation of the cometary diameters proves that comets are by no means eternal bodies.*

No less are all the things mentioned in Book VI, page 337, confirmed by these three comets; nor has anything been asserted by us so far, and in this work on comets, that is not corroborated by them just as firmly, as you will be able to inquire into and examine in a long series in its proper place. But I break off. [Margin: Nec Cometæ recentiores re ſpuunt Theoriam noſtram.] *Nor do the more recent comets reject our theory.*

[Margin: De Deviationibus Caudarum.] *On the deviations of the tails.* And so I turn to the deviations of the tails of these three comets. About their different lengths I ought indeed to have given some notice first, as could also easily be done, now that their distances from the Earth are known; but I consider it superfluous, since you yourself will be able to work out promptly whatever you wish to know. The deviations, however, I have investigated by calculation, with the greatest care, for almost every single day of all three comets, namely by the method we taught on page 466 of Book VIII; and I have brought them all together into one little table, as was done for the other comets in Book VIII, page 488. From it you will now be able to take each thing you wish: both towards which quarter the comet directed its tail, and the distance of the head from the Sun, the angle of the circle of latitude and of the distance, and also the angle of the circle of latitude and of the tail, as well as the angle of deviation.

The earlier comet directed its tail indiscriminately, now towards the north, now towards the south, by 7 to 12 degrees, although its latitude remained constantly northern. [Margin: Magna intercedit diverſitas, inter Cometarum deviationes.] *There is great diversity among the deviations of the comets.* The deflection of the intermediate comet remained northern from the beginning

up to 29 December; thereafter it turned back again continuously towards the south; and it had increased from one degree to 27. The inclination of the tail of the later comet went with a constant course towards the south, increasing from 1 to 12 degrees. All of these things, for that purpose

I have decided to set down here, worked out so scrupulously, so that in future the more exact investigators of the heavens and the stars may compare both these deviations and those presented in Book VIII, page 488, somewhat more carefully with the deflections of future comets; above all, that they may be able to judge all the more exactly concerning all those questions proposed in the passage cited: namely, whether everything asserted there holds good in these comets as well, and how far? Whether, with the passage of ti-

Day	Morning, h m	Longitude of the Sun, A (° ′ sign)	Head of the comet: longitude, F (° ′ sign)	Head of the comet: latitude, F C (° ′)	Place to which the tail was extended: name	Place of the tail: longitude, E (° ′ sign)	Place of the tail: latitude, E D (° ′)	Distance of the head from the Sun, A C (° ′)	Angle of the circle of latitude and of the distance, B C F (° ′)	Angle of the circle of latitude and of the tail, H C D (° ′)	Angle of deviation of the tail, B C D (° ′)	Quarter of the deviation from the circle of distance
				northern	**In the year 1661.**		northern					
3	5h 47m	15° 2′ ♒	0° 2′ ♒	22° 8′	Apex of the western rhombus of Delphinus	11° 47′ ♒	31° 57′	22° 40′	13° 5′	5° 46′	7° 19′	*B.*
5	5h 6m	17° 2′ ♒	7° 21′ ♒	23° 52′	From the distance of the tip of the tail	5° 45′ ♒	29° 4′	24° 55′	23° 32′	15° 4′	8° 28′	*B.*
6	5h 25m	18° 4′ ♒	5° 48′ ♒	24° 35′	From the distance of the tip of the tail	3° 32′ ♒	27° 15′	27° 18′	27° 36′	36° 55′	9° 19′	*A.*
7	4h 48m	19° 3′ ♒	4° 29′ ♒	25° 17′	From the distance of the tip of the tail	3° 7′ ♒	28° 40′	28° 56′	31° 29′	19° 24′	12° 5′	*B.*

Day	Morning, h m	Longitude of the Sun, A (° ′ sign)	Head of the comet: longitude, F (° ′ sign)	Head of the comet: latitude, F C (° ′)	Place to which the tail was extended: name	Place of the tail: longitude, E (° ′ sign)	Place of the tail: latitude, E D (° ′)	Distance of the head from the Sun, A C (° ′)	Angle of the circle of latitude and of the distance, B C F (° ′)	Angle of the circle of latitude and of the tail, H C D (° ′)	Angle of deviation of the tail, B C D (° ′)	Quarter of the deviation from the circle of distance
2	$4^h\ 2^m$	12° 10′ ♑	9° 8′ ♍	27° 33′	The uppermost at the right shoulder of Serpens	27° 22′ ♐	33° 2′	57° 48′	70° 46′	82° 12′	11° 26′	*A.*
				southern	**In the year 1664.**		southern					
14	5^h *m.*	23° 4′ ♐	7° 10′ ♎	21° 36′	Between the base of Crater and the northern one under Crater	18° 0′ ♏	22° 30′	76° 55′	84° 42′	83° 7′	1° 15′	*B.*
18	4^h *m.*	27° 6′ ♐	28′ ♎	24° 54′	Towards the Heart of Hydra	22° 36′ ♎	22° 24′	84° 3′	87° 18′	85° 10′	2° 8′	*B.*
21	4^h *m.*	0° 0′ ♍	27° 47′ ♎	28° 1′		2° 0′ ♏	24° 30′	88° 3′	88° 17′	87° 17′	1° 0′	*B.*
22	4^h *m.*	1° 1′ ♍	24° 16′ ♏	1° 26′	The first from the Heart of Hydra	28° 0′ ♌	26° 34′	84° 15′	86° 27′	84° 41′	1° 46′	*B.*

Day	Morning, h m	Longitude of the Sun, A (° ′ sign)	Head of the comet: longitude, F (° ′ sign)	Head of the comet: latitude, F C (° ′)	Place to which the tail was extended: name	Place of the tail: longitude, E (° ′ sign)	Place of the tail: latitude, E D (° ′)	Distance of the head from the Sun, A C (° ′)	Angle of the circle of latitude and of the distance, B C F (° ′)	Angle of the circle of latitude and of the tail, H C D (° ′)	Angle of deviation of the tail, B C D (° ′)	Quarter of the deviation from the circle of distance
28	1h *m.*	7° 9′ ♍	5° 11′ ♌	49° 0′	The leading one above the shield of the Ship	3° 0′ ♌	42° 43′	54° 37′	54° 48′	75° 35′	20° 47′	*Ort.*
30	10h *v.*	10° 5′ ♍	2° 38′ ♎	39° 21′	Below the right foot of Orion	22° 0′ ♎	34° 0′	46° 40′	39° 20′	55° 41′	16° 21′	*A.*
31	8h *v.*	11° 1′ ♍	2° 23′ ♎	33° 42′	The middle one of Orion's belt	18° 44′ ♎	24° 34′	49° 28′	55° 14′	82° 26′	27° 12′	*A.*
1665												
1	8h *v.*	12° 2′ ♍	4° 5′ ♉	27° 29′	The third from the first bend of Eridanus	24° 43′ ♉	7° 32′	53° 33′	67° 24′	84° 55′	17° 31′	*A.*
3	8h *v.*	14° 9′ ♍	4° 39′ ♉	8° 10′	At the middle of the unformed stars near the jaw [?] of Cetus	17° 30′ ♉	8° 30′	61° 10′	79° 36′	82° 38′	3° 2′	*A.*
5	9h *v.*	16° 10′ ♍	8° 59′ ♉	12° 37′	The fourth in the shield of Orion	9° 0′ ♊	12° 25′	67° 46′	84° 44′	87° 3′	2° 19′	*A.*

Day	Morning, h m	Longitude of the Sun, A (° ′ sign)	Head of the comet: longitude, F (° ′ sign)	Head of the comet: latitude, F C (° ′)	Place to which the tail was extended: name	Place of the tail: longitude, E (° ′ sign)	Place of the tail: latitude, E D (° ′)	Distance of the head from the Sun, A C (° ′)	Angle of the circle of latitude and of the distance, B C F (° ′)	Angle of the circle of latitude and of the tail, H C D (° ′)	Angle of deviation of the tail, B C D (° ′)	Quarter of the deviation from the circle of distance
6	9h *v.*	17° 12′ ♍	8 6′ ♉	10° 22′	Between the stars in the foot and the dewlap of ♉	4° 0′ ♊	12° 0′	70° 27′	86° 13′	83° 53′	2° 20′	*A.*
7	8h *v.*	18° 12′ ♍	8 20′ ♉	8° 26′	The one following the third in the shoulder	18° 23′ ♉	9° 35′	73° 3′	87° 21′	83° 54′	3° 27′	*A.*
9	6h *v.*	20° 9′ ♍	8 9′ ♉	5° 36′	The second in the shoulder of ♉	18° 20′ ♉	7° 29′	77° 4′	88° 41′	84° 4′	4° 37′	*A.*
10	6h *v.*	21° 10′ ♎	3 11′ ♉	4° 23′ northern	Between the uppermost and the second in the shoulder of ♉	18° 51′ ♉	6° 45′	79° 1′	89° 9′	81° 10′	7° 59′	*A.*
17	9h *v.*	28° 25′ ♎	8 25′ ♌	8° 52′	The northern eye of Taurus	3° 43′ ♊	2° 37′	89° 59′	90° 0′	86° 42′	3° 18′	*A.*

Day	Morning, h m	Longitude of the Sun, A (° ′ sign)	Head of the comet: longitude, F (° ′ sign)	Head of the comet: latitude, F C (° ′)	Place to which the tail was extended: name	Place of the tail: longitude, E (° ′ sign)	Place of the tail: latitude, E D (° ′)	Distance of the head from the Sun, A C (° ′)	Angle of the circle of latitude and of the distance, B C F (° ′)	Angle of the circle of latitude and of the tail, H C D (° ′)	Angle of deviation of the tail, B C D (° ′)	Quarter of the deviation from the circle of distance
							northern					
21	9h *v.*	2° 30′ ♒	7° 28′ ♑	2° 33′	The first in the tail of ♈	16° 0′ ♉	1° 47′	84° 59′	89° 38′	88° 1′	1° 37′	*A.*
2	9h *v.*	14° 42′ ♒	6° 31′ ♓	3° 18′	The neck of Aries	28° 47′ ♈	3° 24′	72° 44′	84° 12′	87° 4′	2° 52′	*A.*
				northern	**In the year 1665.**		northern					
6	3h *m.*	16° 50′ ♍	4° 21′ ♑	26° 30′	Between the mouth and the foot of Pegasus	16° 6′ ♐	23° 16′	40° 59′	54° 58′	56° 25′	1° 27′	*A.*
7	3h *m.*	17° 49′ ♍	8° 59′ ♑	26° 13′	At the tip of the wing of Cygnus	29° 38′ ♒	6° 11′	38° 12′	51° 15′	52° 14′	0° 59′	*A.*
8	3h *m.*	18° 48′ ♎	3° 29′ ♑	25° 49′	The leading one in the breast of Pegasus	18° 20′ ♑	8° 49′	35° 32′	47° 23′	55° 0′	5° 37′	*A.*
9	3h *m.*	19° 46′ ♎	7° 50′ ♑	25° 18′	Above the hoof of the left foot of Pegasus	5° 24′ ♐	38° 39′	32° 53′	43° 28′	49° 19′	3° 51′	*A.*

Day	Morning, h m	Longitude of the Sun, A (° ′ sign)	Head of the comet: longitude, F (° ′ sign)	Head of the comet: latitude, F C (° ′)	Place to which the tail was extended: name	Place of the tail: longitude, E (° ′ sign)	Place of the tail: latitude, E D (° ′)	Distance of the head from the Sun, A C (° ′)	Angle of the circle of latitude and of the distance, B C F (° ′)	Angle of the circle of latitude and of the tail, H C D (° ′)	Angle of deviation of the tail, B C D (° ′)	Quarter of the deviation from the circle of distance
11	3h *m.*	21° 44′ ♓	27′ ♈	23° 46′	The right knee of Pegasus	21° 2′ ♓	35° 8′	28° 17′	35° 2′	41° 42′	6° 42′	*A.*
13	3h *m.*	23° 41′ ♓	13′ ♈	21° 48′	The head of Andromeda	9° 38′ ♈	25° 42′	24° 4′	26° 27′	39° 19′	12° 52′	*A.*
15	3h *m.*	25° 38′ ♓	27′ ♈	9° 38′	The left shoulder-blade of Andromeda	17° 0′ ♈	23° 20′	20° 33′	17° 3′	31° 3′	14° 0′	*A.*
16	3h *m.*	26° 36′ ♓	10′ ♈	8° 27′	The right shoulder-blade of Andromeda	18° 0′ ♈	27° 6′	18° 57′	13° 23′	23° 9′	9° 46′	*A.*
17	3h *m.*	27° 35′ ♓	41′ ♈	7° 13′	The upper one in the hand of Andromeda	13° 37′ ♈	43° 50′	17° 27′	9° 35′	17° 3′	7° 28′	*A.*

[680] me, those deviations could be bound by fixed laws? I by no means despair of this, provided that our posterity devote themselves, with unwearied labour, to the most exact observations. We could indeed examine this matter somewhat more deeply here, but I shall hand the torch to others who have more leisure, so that they may also weave their own calculation onto these of mine. [Margin: Deviationes caudarum nondum prorsùs certis aſtringuntur legibus.] *The deviations of the tails are not yet wholly bound by fixed laws.*

Finally, I do not doubt that it has been abundantly deduced by us, and plainly demonstrated, both by sound reasons and by the observations of so many comets, through competent and exact calculation, as was proposed, that comets by no means move in the sublunary air but in the highest aether, and run their course there: with an apparent motion that is indeed unequal and most diverse, yet supremely regular and ordered, as regards both the longitudes, latitudes and node, and the angle of inclination, as the following little table of these three comets also shows, together with that of the others given in Book I, page 123; but with a true motion almost equal, and that in a trajectory almost straight, or rather conic, continually curved and inclined towards the Sun and the plane of the ecliptic, tending now towards this quarter of the sky, now towards that. [Margin: Autor ſibi perſuadet, abundè ſatis Co metarum ſedem, motumq́; tam apparentem, quàm verum ſe demonſtraſſe.] *The author is convinced that he has demonstrated abundantly enough the seat of the comets and their motion, both apparent and true.*

[680] On the page this table stands above the paragraph that precedes it here, filling the upper part of the leaf across its whole width; it has no caption. Its head is ruled in bands: the words Head of the comet stand once over the longitude and latitude of the head, and Places to which the tail was extended once over the name, longitude and latitude of the tail's place; the capital letters printed under the heads (A; F; F C; E; E D; A C; B C F; H C D; B C D) are carried in the column heads here, as are the printed units (degrees, minutes and sign; hours and minutes). The first column is headed with the words month and days, and the second with morning; in the sections for 1664 and 1665 the second column gives only the hour, followed by the italic letters m. or v., kept as printed. The words northern and southern stand in the head row of each comet's section and, once each, beside a later row, as printed: northern on the second line of the 10 January row in the latitude of the head, and northern on a line of its own after 17 January in the latitude of the tail. The year 1665 stands on a line of its own in the first column between 31 December and 1 January. The month names are set sideways, reading upward, beside the day figures and are not in the cells: February beside 3 to 7 February 1661; March beside the 2 that follows; December beside 18 to 28 December 1664; January beside 6 to 10 January 1665; February beside the 21 and 2 that close the 1664 section; April beside 9 to 13 April 1665. No month name stands beside 14 December 1664, 1 to 5 January 1665, 17 January 1665, or 6 to 8 and 15 to 17 April 1665. The last column carries the italic letters B. and A. and once Ort., unexpanded on the page and kept as printed. The place of the tail is left blank for 21 December 1664. In the 13 April 1665 row, the degrees of the angle of deviation are printed 12, the 2 fully inked and the 1 before it a much paler, under-inked impression; the value is 12° 52′. Rules divide the table into one section for each comet and the sections into groups of rows.

Variation of the angle of inclination, of the node, of the longitudes, of the latitudes, and of the motion in the circle of the path, of the three more recent comets.

Comet of the year	At the time of appearance	Angle of inclination	Node, or place of intersection	Longitude	Latitude	Motion of the comet in its track
1661	About the beginning	Decreasing.	Direct.	Retrograde.	Increasing. *B.*	Fairly slow.
	middle	Decreasing.	Direct.	Retrograde.	Stationary. *B.*	Slower.
	end	Decreasing.	Direct.	Retrograde.	Decreasing. *B.*	Very slow.
1664	About the beginning	Decreasing.	Direct.	Retrograde.	Increasing *A.*	Fairly fast.
	middle	Decreasing.	Direct.	Retrograde.	Stationary. *A.*	Very fast.
	end	Decreasing.	Direct.	Stationary and direct.	Decreasing, increasing. *A. B.*	Slower, very slow.
1665	About the beginning	Increasing.	Retrograde.	Direct.	Decreasing, *B.*	Fast.
	middle	Increasing.	Retrograde.	Direct.	Decreasing. *B.*	Slower.
	end	Increasing.	Retrograde.	Direct.	Decreasing. *B.*	Slow.

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Furthermore, that none of all the comets above which have been mentioned crossed the limits of the planetary system, but that each had its origin and its passing away within it: so much so that all the comets which have come our way so far, and all their phenomena, cannot fail, unless I am mistaken, to be saved fairly consistently in a similar way by one and the same fixed hypothesis, and to be freed from all inconveniences and absurdities, even though one comet has always been extremely different from another as regards its course, both apparent and true, and the proportion of its velocity. I hope also that all the remaining comets still to come can be dealt with in that way, that

[681] On the page this table, with its three-line caption, stands between the sentence ending tending now towards this quarter of the sky, now towards that and the sentence beginning Furthermore; it is set wider than the text, its first column standing out into the margin. Rules divide it into one group of three rows for each comet. In the second column the words About the beginning stand in the first row of each group, and middle and end below the word beginning, so that each reads about the middle and about the end. The year stands only in the first row of each group. In the latitude column the letters B. and A. are printed after the word, unexpanded on the page and kept as printed; in the end row of 1664 both stand, after two abbreviated words, Decr. and Creſc. The cells of the end row of 1664 in the longitude and motion columns are likewise abbreviated on the page (Stat.&Direct. and Remiſſ.tardiſſim.), and the 1665 latitude in its first row is followed by a comma, not a point.

is to say, no less successfully and fittingly, with all force entirely set aside. [Margin: Vniverſi Cometæ, ut ut ſint diverſiſſimi, ſub unâ, eâq; fixâ hypotheſi comprehenduntur.] *All comets, however extremely different they may be, are comprised under one hypothesis, and that a fixed one.*

I freely grant, honoured reader, that an easier and shorter method can be given, by which the straight trajection of comets can be explained and determined with less labour and a much shorter calculation, especially by tangents, by the method of the Reverend Father Ignatius Gaston Pardies [Ignace-Gaston Pardies], of the Society of Jesus. [Margin: Autor concedit, poſſe Trajectionem Cometarum rectam faciliori viâ cxpediri.] [recte: expediri] *The author grants that the straight trajection of comets can be worked out by an easier way.* But however that may be, I am nevertheless prevented as yet, for many weighty reasons, from conceding that all the phenomena in general can be satisfied in that way; indeed, not even, precisely, the motion — the daily apparent one. I do not deny that this can be achieved approximately, and even sometimes, in certain cases, fairly well, especially in the neighbourhood of the observations assumed; but in places farther on, with the passage of time, especially in the ageing course of the comet, that hypothesis sometimes departs from the truth by far too much. [Margin: Nec motus apparens,nec verus motus Cometicus per Tangentes rectè definitur.] *Neither the apparent nor the true motion of a comet is correctly determined by tangents.* Not to mention the true distances of the comet from the Earth, the true motion in the trajectory, and so on, which are not even roughly determined by that theory, although by our hypothesis all these are successfully worked out.

For, first, in that hypothesis which is constructed by means of tangents, a line entirely straight is supposed, along which the comets are carried, as though they always proceeded strictly beneath an absolutely great circle and never turned aside from it by so much as a nail's breadth; as we clearly understand from the *Dissertation on Motion and Nature* of the Reverend Father Pardies, page 73. [Margin: Quare Theori[[a/â]] ſuper tangentes exſtructa adeò evidenter nonnunquā ab ipſo Cælo deflectet ?] *Why will the theory built on tangents sometimes so evidently depart from the sky itself?* And yet it has been demonstrated by us abundantly and amply in this work that no comet has ever shone (however others too may have thought otherwise) which followed the course of a great circle wholly exactly, but that each has strayed from the path of that circle with a most evident, and sometimes with a very notable, deviation. From this it is altogether plain that the trajectory of comets is by no means a line from among the tangents; above all because the true trajectory does not even run wholly straight, but in all comets inclines not a little and curves towards the Sun, so that it always describes and forms a curved line or course, or a quasi-conic one, as has been demonstrated at length elsewhere. [Margin: Cometarum Trajectoria nulla eſt Tangens.] *The trajectory of comets is no tangent.*

Second, the motion of the nodes, which otherwise contributes a very great deal to the course of comets, is not attended to at all in this hypothesis, nor can

it be duly attended to and observed in every respect. For at the beginning of the appearance of comets, from rather few observations of a few days, which serve for the tangents, the said motion of the nodes cannot be explored; and yet it is of the greatest importance to know it at once, from the very outset. [Margin: Motus Nodorum maximè obſtatTheoriæ, quæ ex Tangentibus conſtruitur.] *The motion of the nodes stands most of all in the way of the theory that is constructed from tangents.* For since this motion is fairly often even plainly contrary to the comet's proper motion in its track, the comet is certainly made much faster or slower by it, according, that is, to the angle of inclination and the motion of the nodes. Hence it can never happen that the apparent motion of the comet is determined quite exactly in every respect (as must shortly be shown at greater length), much less the distance from the Earth, and so on, as indeed succeeds precisely enough according to our theory, by the drawing of the diagram alone. [Margin: Verum intervallum Cometarum à Terrâ ex dictâ hypotheſi nunquam definiri poteſt.] *The true distance of comets from the Earth can never be determined from the said hypothesis.* I do indeed almost concede, together with the most learned P. Petito [Pierre Petit] in the *Dissertation on Comets*, that the proportion of the distances can be determined from the tangents: that is, how many times farther from the perigee, in point of distance, or nearer to it, the comet was or will be on this or that day. But in this way we obtain nothing and determine nothing, as the distinguished Petit rightly argues on this same matter on page 279 of the *Dissertation on Comets* (to whose opinion I fully subscribe), when he says: [Margin: Autoris ſententiam Cl. Petitus confirmare videtur.] *The distinguished Petit seems to confirm the author's opinion.* [French] *This, I say, teaches us nothing of its true distance: for it is only a supposition that one makes of the first, which is unknown to us. The ratio or relation that one gives of two magnitudes does not express the quantity of either the one or the other: to say that one man is three times richer than another, you will not for that reason lend him money without security, if you do not know that other man. Thus, when one says that the comet was, on such a day, four or five times farther from the earth than on another day, this does not determine for us what that distance is in a known and certain measure, as I have seen many people believe.* [Margin: Nulla genuina diſtantia ex proportione Intervallorum cognoſcitur.] *No genuine distance is known from the proportion of the distances. And yet that is what would be very necessary, whether to place the comet somewhere in the sky or to determine the size of its circle: and even then one would need at least three points of the distance from the Earth to this curved line in order to find its centre, and even to suppose it a circle.* Therefore, since from that hypothesis not even for a single day is the true distance of the comet from the Earth disclosed to us, we know absolutely nothing at all in this respect. Indeed, if it were granted straight away to place the trajectory at some true distance of the comet, the matter would be of some importance; but that very thing is not yet known from the beginning, and we must first explore it. To me, by contrast, that very thing is evident at once from our hypothesis: namely, in what place, and at what distance with respect to the Earth and the Sun, the

trajectory necessarily runs out; whether the comet sets its course away from the Sun or towards the Sun; whether under such an angle of obliquity or under another. [Margin: Ex hypotheſi Autoris ſtatim ab initio patet locus, ductusq́; Trajectoriæ; & per conſequens etiam intervallum.] *From the author's hypothesis the place and the course of the trajectory are evident at once, from the beginning; and consequently the distance as well.* From this we learn at once the genuine distance itself of the comet from the Earth on any day whatever, no less than the inclination of the trajectory to the trace or plane of the ecliptic; and these, however, are in no way obtained from the tangents.

Third, the said theory does not satisfy us in certain other principal phenomena either. For I do not understand how the stations and retrogressions of comets are to be properly explained and determined; and yet no one in the world can deny that these really occur in very many comets. [Margin: Cometarum ſtationes & retrogreſſiones, Terr[[à/â]] inprimis ſtabili, per tangentes explicari haud poſſunt.] *The stations and retrogressions of comets cannot be explained by tangents, especially with the Earth at rest.* This indeed is very true: that it can be foreseen where the comet is slower or faster, in what place the perigee falls, and in what manner it approximately quickens and slackens its course. But how a comet on a tangent can be shown stationary and retrograde, above all with the Earth wholly at rest (as indeed the Reverend Father Pardies persuades himself), I certainly do not grasp; but I acknowledge in this the dullness of my own wit. Nor do I comprehend by what way it could make its passage oblique in the course of its run, given, that is, a tangent, which entirely resists inflections of this kind. Therefore this hypothesis is not universal, nor can it establish all the phenomena, although its method of inquiry is not so very laborious. Meanwhile I leave that hypothesis standing in its own strength, holding firmly that (if the matter need not be taken so strictly and precisely) the daily apparent proper motion can approximately be explored by it; but that great things can in no way be built upon it, nor can the observations of others, obtained with proper instruments, be judged by that hypothesis. I consider it safer if, at the first appearances of comets, we draw sound observations from the sky itself with large and exquisite instruments, and thereafter work out each and every thing: both the apparent motion, by suitable calculation, from the observed distances wholly freed of refraction, and the true motion. In this way we shall not only construct an entirely accurate hypothesis, but shall also duly obtain the true distance from the Earth and the corresponding parallaxes for any days whatever. [Margin: Quâ viâ exquiſitiora inCometis obtineamus.] *By what way we may obtain more exact results in comets.* It is better, therefore, to uncover truer results with a little more labour than less certain ones with somewhat lighter effort. [Margin: Etiamſi ſit moleſtius, præſtat tamen viâ incedere tutiori.] *Even if it is more troublesome, it is nevertheless better to proceed by the safer way.* For it is not the case that one who seeks the fruit should spare the labour.

Before we reach that point, however, and show clearly that the hypothesis from tangents goes notably astray even in the apparent motion, and indeed

that it is altogether necessary for that motion to depart from the truth, even if you possess the most accurate observations of all and apply them to it, I shall briefly reply to the Reverend Father Pardies's argument against the motion of the Earth, drawn from the straight trajection. For he says, on page 70 of the *Dissertation on Comets*: [Margin: R. P.Pardies argumentum contra motum Terræ.] *The Reverend Father Pardies's argument against the motion of the Earth. "It is very difficult for that annual motion of the Earth to be consistent with that straight trajection of the comets. For in no way would comets be observed to move in the same plane, or on a greater circle; rather, from that double motion, the straight motion of the comet and the circular motion of the Earth, a curved phenomenon of motion would necessarily arise. Nor can it be that, when lines are drawn to two moving bodies, one of which is carried straight on and the other in a circle, a plane surface is generated (unless perhaps those two paths, the straight and the circular, lie in the same plane); rather, the surface so produced will be of the kind that our stonecutters call 'ruled and arched' [Regulatum atque arcuatum]. Its curvature ought to appear more plainly in the middle of the comet's course above all, because of the nearness of the moving bodies; and especially in those comets which, although they are observed very near the earth, nevertheless advance rather slowly: such as was the comet of the year 1618, which at its greatest speed scarcely exceeded three degrees a day. This argument, indeed, I consider to be of such force that I think nothing has yet been brought by the Copernicans against the immobility of the Earth that would equal the force of this retonsio [retonſionis]."*[682] [Margin: Autoris reſponſio ad illius argumentum.] *The author's reply to his argument.* From this it is evident that the Reverend Father Pardies certainly supposes that all comets move beneath the track of a great circle exactly, that is, in an altogether straight line, or tangent; but we wholly deny this major premise of his argument. For in all comets, even in that very one of 1664 of which he speaks, I have demonstrated the plain contrary: namely, that all of them deviate most evidently from a straight line, or from the course of a great circle; and moreover that, as regards their true motion in the trajectory, they deviate not a little (sometimes more, sometimes less) from a straight path towards the Sun and the Earth, as has been demonstrated amply enough by the calculation above, both of this comet and of all the other comets. [Margin: Deſtruct[[à/â]] majore illius argumenti,corruunt omnia.] *When the major premise of his argument is destroyed, everything collapses.*

If, then, some force is to be attributed to the Reverend Father Pardies's argument, when he argues roughly to this effect: "Since comets move in a straight line, and no straight line results from a straight line and a circle, but it necessarily passes into a curve, unless, as he says, the two paths, the straight and the circular, lie in the same plane; therefore the motion of the Earth is in no way given"; [Margin: Autor eodem argumento, ſed inverſo, motum Terræ propugnat.] *The author defends the motion of the Earth with the same argument, but inverted.* then certainly this argument too, merely inverted, has the force of

[682] So printed. The word is not a known Latin form, and its intended reading is not settled here.

proving the motion of the Earth, namely: "Since all comets, rightly observed and investigated by calculation in this work, have by no means kept their path precisely beneath a great circle (contrary to the opinion of the Reverend Father Pardies), much less along a wholly straight line and tangent, but along an orbit partly oblique, with the trajectory curved, both the apparent and the true one, or conic, as has been fully deduced; hence the Earth is by no means at rest, but is necessarily carried in an orbit around the Sun." Or if by this argument the motion of the Earth is not proved demonstratively, which I by no means claim either, since the Reverend Father Pardies's argument is not of that kind, [Margin: Hoc argumentum, licet non ſit apodicticum, ſaltem maxim[[è/é]] eſt probabile.] *This argument, though it is not apodictic, is at least extremely probable.* the motion of the Earth is nevertheless extremely probable from it: since for the Reverend Father Pardies the straight motion of the comets has been entirely destroyed. I do not, however, infer these things as though I wished to demonstrate the motion of the Earth absolutely by them; by no means. Rather, I infer them because the mobility of the terrestrial globe can be established much more readily by this argument of the Reverend Father Pardies than its immobility; and above all so that his argument, drawn from the straight trajection, may not raise a doubt in anyone's mind. [Margin: Autor confidit cum tempore prægnantiora argumenta pro motu Terræ proditura.] *The author is confident that in time weightier arguments for the motion of the Earth will come forth.* I am fully confident that, with the passage of time, weightier arguments, drawn from the annual parallax of the orb, will be brought to light, by means of which the motion of the Earth will be established not merely probably but demonstratively; although all comets, as we have already said in the proper place, fight on the side of the motion of the Earth, so that I am compelled to assert again and again that not even a single comet could ever be freed and released from all inconveniences and absurdities while the Earth stands wholly still, as we said in Book IX, page 589. [Margin: Omnes Cometæ pro motuTerræ militant.] *All comets fight on the side of the motion of the Earth.*

But let it suffice to have touched briefly on these matters, of which I have a mind to speak at greater length at some time, so that we may return to the said hypothesis founded on tangents and weigh and investigate it scrupulously: whether the daily motion too, derived from that hypothesis, comes out so accurately at every time and place (as very many indeed firmly persuade themselves). [Margin: An hypotheſis ex tangentibus conſtructa,adeò accuratè conveniat ipſis obſervationibus, ut quibusdam eſt perſuaſum?] *Does the hypothesis constructed from tangents agree as accurately with the observations themselves as some are persuaded?* The Reverend Father Pardies, indeed, at the end of his little work on comets, has produced the courses of two comets, namely those of 1590 and 1585, observed by Tycho himself, by which he tries to establish the highest agreement of his hypothesis with the observations themselves. But truly, if you examine the matter somewhat more carefully, it still departs far indeed from the truth, or from the observations. [Margin: Dictam hypotheſin evidenter [[à/a]]

verò aberrare commonſtratur.] *The said hypothesis is shown to depart evidently from the truth.* In the neighbourhood of the assumed observations it agrees well enough, I admit, as is evident in the comet of 1590 around the 23rd, the 24th and March 6; but consider, I beg you, what happens a little later, namely on February 27. For in three days the discrepancy had already grown to 16′, and in five days, that is, on March 1, to 34′, as the ephemeris of the Reverend Father Pardies at the end of his little work testifies; and this notwithstanding that the observations of March 6 were assumed, and that the daily motion equalled only three degrees. There has therefore been no slight error, when, in a motion of three degrees, within the space of only five days, the hypothesis departs from the observations themselves by more than half a degree. What do you think? How much discrepancy would arise if one of the comets had lasted for some months, and this theory had had to be constructed, and the motion deduced, from the observations of the earlier days? Would not the deviation rise to whole degrees, and the motion be thrown into complete disorder? Further, that other comet, of 1585, does indeed answer somewhat better to observation: although the hypothesis rests on the two extreme observations and an intermediate one, namely those of October 20 and 30 and November 9, it nevertheless errs, within an interval of four or six days, towards the end, by 6′ or 7′, that is, by almost a fourth part, since the daily proper motion at that time was no more than 30′. [Margin: Res eadem, Cometâ 1585 probatur.] *The same thing is proved by the comet of 1585.* From this, again, you easily understand what would have happened if the foundation of the hypothesis were laid in the observations of the earlier days, in order to foreknow the motion of the following days. What kind of agreement this is, then, I ask you to judge for yourself.

But let us set out the matter somewhat more clearly still with those three more recent comets, whose observations, certainly, acquired with due diligence by means of brass instruments that were sufficiently large and [Margin: Autor tribus pariter recentioribus Come-] *The author likewise, with the three more recent come-* properly made, hardly anyone will be able to call into question. [Margin: tis demonſtrat [?] d ctam hypotheſin neutiquã cælo congruere.] *ts demonstrates [?] that the said hypothesis by no means agrees with the heavens.* Therefore, if anything accurate is ever to be drawn out of this hypothesis, it ought by rights to happen in these comets. For that reason, to look into this matter the more deeply, I myself have undertaken to construct an ephemeris of all three comets according to the hypothesis of tangents, from my very own observations, and indeed from those that I held to be more accurate than others and better suited to this business, as anyone will be free to examine; and to do so by the method of the Reverend Father Pardies (whose method is very easy), namely by investigating the proper motion for each single day of the apparition. [Margin: Autor ex ſuis obſervationib[9], methodo R. P. Pardies, Ephemeridem motûs diurni conſtruxit.] *The author, from his own observations, by the method of the Reverend Father Pardies, constructed an ephemeris of the daily motion.* And so that there may be no one, to whom a doubt perhaps occurs, who cannot call the

calculation back again at will and examine everything the more correctly, I shall at the same time append the data of the calculation. I have taken, moreover, the earlier observations, of February 3, 5 and 7, since this comet of 1661 was made out more accurately at the beginning than on other days.

Observations for the calculation of the comet of 1661. [Pro calculo Cometæ 1661 Obſervationes.]

[Margin: Data pro calculo Cometæ 1661.] *Data for the calculation of the comet of 1661.*

February	Morning	Proper motion	Longitude of the comet	Latitude of the comet
3	$5^h\ 47^m$	3° 1′	10° 1′ 48″ ♒	22° 8′ 11″ *B.*
5	$5^h\ 6^m$	2° 57′	7° 20′ 38″	23° 51′ 55″
7	$4^h\ 48^m$		4° 28′ 56″	25° 16′ 43″

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From these data, therefore, taken from the preceding Book, page 739, I worked out with due diligence the calculation of this hypothesis by tangents, and I found that the comet, around its greatest speed, covered 1° 36′ 37″ in the space of 24 hours, and 4′ 23″ in the motion of one hour, the perigee falling on February 2 at $2^h\ 49^m$ in the morning. [Margin: Maxima velocitas, & Perigæum Cometæ 1661, juxt[[à/a]] calculumAutoris.] *The greatest speed and the perigee of the comet of 1661, according to the author's calculation.* How great the motion was on each single day I have entered in the following table, together with the daily motion of the other two comets; and to these I have added the daily motion of all of them, derived from the observations and extracted from Table F of Book X, from the *Mantissa*, table on page 111, and from Table G on page 33 of the *Description of the Comet of 1665*. But first I shall add the data of the two following comets from our observations, set out partly in the *Mantissa* and partly in the *Description* of the later comet.

Observations for the calculation of the comet of 1664. [Pro calculo Cometæ 1664 Obſervationes.]

[Margin: Data pro calculo Cometæ 1664.] *Data for the calculation of the comet of 1664.*

December	Morning	Proper motion in the orbit	Longitude of the comet	Latitude of the comet
15	$5^h\ 21^m\ 30^s$	4° 12′ 22″	6° 24′ 5″ ♎	22° 23′ 26″ *A.*
18	$5^h\ 58^m\ 30^s$	6° 25′ 50″	3° 14′ 6″	25° 26′ 39″
21	$4^h\ 5^m\ 0^s$		27° 57′ 24″ ♍	29° 51′ 49″

[683] The table is ruled in five columns, with the month in the head of the first. The proper motion is printed half a line lower than the other columns, each value standing between the lines of two successive dates; here each stands in the row of the earlier date, and the last date has none. The sign of Aquarius is printed after the first longitude only, and the letter *B.* after the first latitude only.

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This comet, following this theory, passed through 13° 9′ 10″ in one day around its greatest speed, so that the daily motion was 33′ 29″; and it reached perigee on December 29 at 8^h 29^m 30^s in the morning. [Margin: Maxima velocitas, & Perigæum Cometæ 1664, juxt[[á/a]] calculum Autoris.] *The greatest speed and the perigee of the comet of 1664, according to the author's calculation.*

Observations for the calculation of the comet of 1665. [Pro calculo Cometæ 1665 Obſervationes.]

[Margin: Data pro calculo Cometæ 1665.] *Data for the calculation of the comet of 1665.*

April	Morn-ing	Proper motion in the orbit	Longitude of the comet	Latitude of the comet
6	3^h 0^m	16° 6′	14° 21′ 0″ ♎	26° 30′ 0″ *B.*
10	3^h 0^m	10° 45′	1° 59′ 0″ ♍	24° 37′ 0″
13	3^h 0^m		13° 13′ 0″	21° 48′ 0″

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The observations of this comet around its greatest speed show a daily motion of 4° 9′ 38″, and an hourly one of 10′ 24″; and the perigee falls on April 5 at 11^h 21^m in the evening. [Margin: Maxima velocitas, & Perigæum hujus Cometæ, juxt[[á/a]] calc. Autoris.] *The greatest speed and the perigee of this comet, according to the author's calculation.*

Ephemeris of the three comets, constructed from the tangents. [Ephemeris trium Cometarum ex tangentibus conſtructa.]

[684] The table is ruled in five columns, with the month in the head of the first. The proper motion in the orbit is printed half a line lower than the other columns, each value standing between the lines of two successive dates; here each stands in the row of the earlier date, and the last date has none. The sign of Libra is printed after the first longitude and the sign of Virgo after the third, none after the second; the letter *A.* stands after the first latitude only.

[685] The table is ruled in five columns, with the month in the head of the first; the time and the proper motion are given to the minute only. The proper motion in the orbit is printed half a line lower than the other columns, each value standing between the lines of two successive dates; here each stands in the row of the earlier date, and the last date has none. The sign of Pisces is printed after the first longitude and the sign of Aries after the second, none after the third; the letter *B.* stands after the first latitude only.

1661 February	Daily motion from the hypothesis	Daily motion from our observations	Difference	1664 December	Daily motion from the hypothesis	Daily motion from our observations	1664 December	Difference	1665 April	Daily motion from the hypothesis	Daily motion from our observations	Difference
$2^h\ 49^m$ morning				$8^h\ 30^m$ morning			$8^h\ 30^m$ morning		$11^h\ 21^m$ evening			
2	1° 36′			29			29		5	4° 9⅔′		
3	1° 36′			30	13° 9′	12° 51′	28	18′	6	4° 7′		
4	1° 36′	1° 34′	2′	31	11° 54′	12° 4′	27	10′	7	4° 2′	4° 6′	4′
5	1° 36′	1° 34′	2′	1	9° 59′	9° 58′	26	1′	8	3° 54′	4° 3′	9′
6	1° 35′	1° 33′	3′	2	8° 2′	7° 57′	25	5′	9	3° 46′	3° 55′	9′
7	1° 34′	1° 23′	11′	3	6° 23′	6° 18′	24	5′	10	3° 36′	3° 49′	13′
8	1° 34′	1° 16′	18′	4	5° 3′	5° 6′	23	3′	11	3° 24′	3° 38′	14′
9	1° 33′	1° 10′	23′	5	4° 4′	4° 8′	22	4′	12	3° 13′	3° 26′	13′
10	1° 31′	1° 4′	27′	6	3° 17′	3° 18′	21	1′	13	3° 1′	3° 14′	13′
11	1° 30′	0° 59′	31′	7	2° 43′	2° 46′	20	3′	14	2° 50′	3° 3′	13′
12	1° 29′	0° 54′	35′	8	2° 16′	2° 13′	19	3′	15	2° 37′	2° 53′	16′
13	1° 28′	0° 49′	39′	9	1° 54′	1° 51′	18	3′	16	2° 27′	2° 43′	16′
14	1° 26′	0° 44′	42′	10	1° 38′	1° 35′	17	3′	17	2° 17′	2° 36′	19′
15	1° 24′	0° 40′	44′	11	1° 25′	1° 21′	16	4′	18	2° 7′	2° 30′	23′
16	1° 23′	0° 36′	47′	12	1° 13′	1° 10′	15	3′	19	1° 59′	2° 24′	25′
17	1° 21′	0° 33′	48′	13	1° 5′	1° 1′	14	4′	20	1° 50′	2° 20′	30′
18	1° 19′	0° 30′	49′	14	0° 56′	0° 55′	13	1′	21	1° 42′	2° 18′	36′
19	1° 18′	0° 27′	51′	15	0° 51′	0° 48′	12	3′	22	1° 36′	2° 13′	37′
20	1° 16′	0° 24′	52′	16	0° 46′	0° 42′	11	4′	23	1° 29′	2° 9′	40′
21	1° 15′	0° 22′	53′	17	0° 40′	0° 40′	10	0′	24	1° 23′	2° 5′	42′
22	1° 12′	0° 22′	50′	18	0° 37′	0° 33′	9	4′	25	1° 17′	2° 1′	44′
23	1° 11′	0° 21′	50′	19	0° 34′	0° 31′	8	3′	26	1° 13′	1° 58′	45′
24	1° 9′	0° 21′	48′	20	0° 31′	0° 26′	7	5′	27	1° 8′	1° 55′	47′
25	1° 7′	0° 21′	46′	21	0° 28′	0° 24′	6	4′	28	1° 4′	1° 52′	48′
26	1° 6′	0° 20′	46′	22	0° 25′	0° 21′	5	4′	29	1° 0′	1° 49′	49′
27	1° 4′	0° 20′	44′	23	0° 24′	0° 20′	4	4′	30	0° 56′	1° 46′	50′
28	1° 2′	0° 19′	43′	24	0° 22′	0° 18′	3	4′				
1	1° 0′	0° 19′	41′	25	0° 21′	0° 17′	2	4′				
2	0° 59′	0° 18′	41′	26	0° 19′	0° 16′	1	3′				
3	0° 58′	0° 18′	40′	27	0° 18′	0° 15′	30	3′				
4	0° 56′	0° 18′	38′	28	0° 16′	0° 14′	29	2′				
5	0° 54′	0° 17′	37′	29	0° 15′	0° 12′	28	3′				
6	0° 53′	0° 17′	36′	30	0° 15′	0° 11′	27	4′				
7	0° 51′	0° 16′	35′	31	0° 14′	0° 9′	26	5′				
8	0° 50′	0° 16′	34′	1	0° 13′	0° 8′	25	5′				
9	0° 48′	0° 15′	33′	2	0° 12′	0° 7′	24	5′				
10	0° 47′	0° 15′	32′	3	0° 11′	0° 6′	23	5′				
11	0° 46′	0° 14′	32′	4	0° 11′	0° 5′	22	6′				
12	0° 45′	0° 14′	31′	5	0° 10′	0° 6′	21	4′				
13	0° 43′	0° 13′	30′	6	0° 10′	0° 7′	20	3′				
14	0° 42′	0° 13′	29′	7	0° 10′	0° 8′	19	2′				
15	0° 41′	0° 12′	29′	8	0° 9′	0° 9′	18	0′				

1661 Febru-ary	Daily motion from the hy-pothesis	Daily motion from our obser-vations	Dif-fer-ence	1664 De-cem-ber	Daily motion from the hy-pothesis	Daily motion from our obser-vations	1664 De-cem-ber	Dif-fer-ence	1665 April	Daily motion from the hy-pothesis	Daily motion from our obser-vations	Dif-fer-ence
16	0° 40′	0° 12′	28′	9	0° 9′	0° 10′	17	1′				
17	0° 39′	0° 11′	28′	10	0° 8′	0° 11′	16	3′				
18	0° 38′	0° 11′	27′	11	0° 8′	0° 12′	15	4′				
19	0° 37′	0° 10′	27′	12	0° 7′	0° 13′	14	6′				
20	0° 36′	0° 10′	26′	13	0° 7′							
21	0° 35′	0° 9′	26′	14	0° 7′							
22	0° 34′	0° 9′	25′									
23	0° 33′	0° 9′	24′									
24	0° 32′	0° 8′	24′									
25	0° 31′	0° 8′	23′									
26	0° 30′	0° 7′	23′									
27	0° 30′	0° 7′	23′									
28	0° 29′	0° 6′	23′									

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You have, therefore, in the attached table the ephemeris of the three more recent comets, constructed by the method of the Reverend Father Pardies and according to the tangents. Others no less have used this hypothesis for these comets, and indeed very celebrated men: above all the distinguished Cassinus [Giovanni Domenico Cassini], the distinguished Anzoutius [Adrien Auzout] and the Reverend Father Pardies. [Margin: Discrepantia inter hypotheſin ex tangentibus, & ipſas obſervationes.] *The discrepancy between the hypothesis from*

[686] The table fills the page and is ruled in thirteen columns, in three blocks divided by double rules, one block for each comet: 1661 (four columns), 1664 (five) and 1665 (four). The head of each date column gives the year and month and, below them, a time of day in hours and minutes ($2^h\ 49^m$ in the morning for 1661, $8^h\ 30^m$ in the morning in both date columns of 1664, $11^h\ 21^m$ in the evening for 1665), set here as the first row of the table. The 1664 block has two date columns, both headed 1664 December: the first runs forward from the 29th through the 31st, then from 1 to 31, then from 1 to 14; the second runs backward from the 29th to the 1st, then from 30 to 14. The 1661 date column runs from 2 to 28 and then from 1 to 28; the 1665 column from 5 to 30. Month names are printed vertically inside three date columns, beside the figures: *Martii.* (of March) beside the dates 4 to 8 of the second run in the 1661 column; *Novem- bris.* (of November) beside the dates 4 to 8 of the third run in the first 1664 column, the only label in that column; in the second 1664 column *Decembris.* (of December) beside the dates 24 to 20 and again beside 9 to 5, and *Novembris.* beside 24 to 20 of the second run. Each value stands on its own date line; unlike the tables on the preceding page, no value is printed between two lines, and none is moved here. A cell carries what is printed in it and is left empty where the page prints nothing; the long empty lower part of the 1664 and 1665 blocks is ruled but blank on the page. The first daily motion from the hypothesis for 1665 is printed as 9 minutes with a raised 2 over a 3, rendered as 9⅔′. In the row for February 6 of 1661 the difference is printed as 3′, while the two motions printed beside it are 1° 35′ and 1° 33′.

the tangents and the observations themselves. For the comet of 1661 the discrepancy between the motion from the tangents and the motion investigated from the observations themselves does indeed rise to only 2′ or 3′ in the first 3 or 4 days, since the observations of those days were laid down as the foundation. In the following days, however, this ephemeris errs in defect by 10′, 20′, 30′, 40′, and indeed around February 21 by as much as 53′. [Margin: Dicta hypotheſis in Cometa 1661 ad 53 Min. exorbitat.] *The said hypothesis goes astray in the comet of 1661 by as much as 53′.* For it shows the daily motion at this time as 1° 15′, whereas the observations themselves show it as only 22′, as was clearly established by a very full calculation, set out at length in Book X. Indeed, toward the end, where the daily motion was in reality only 6′, the hypothesis would have it be 29′. This exorbitation is certainly very perceptible when 29′ is supposed in place of 6′ and 53′ in place of 22′; and just so, it can in no way be defended or excused.

If I had used other people's observations to build this ephemeris, anyone would easily be persuaded that this disagreement in the motion lay hidden in the difference between the observations, namely that one observer had perhaps caught the thing more accurately than another. [Margin: Deviatio hujus hypotheſeos non in obſervationes rejicienda eſt.] *The deviation of this hypothesis is not to be thrown back on the observations.* But since I took my own observations as the foundation, namely those made on February 3, 5 and 7, the matter is free of all suspicion; and nevertheless the hypothesis still deviates so enormously from those same observations. If 1′ or 2′ were lost in 10′ or 20′, the matter could be pardoned; but that it goes astray twofold, threefold, and indeed in certain places almost fourfold, as happens at the end of March, is truly intolerable. [Margin: Quod in triplo, imò quadruplo peccat, condonari haud poteſt.] *That it errs threefold, indeed fourfold, cannot be pardoned.*

In what part this aberration lies hidden, however, and whether this hypothesis can be corrected and improved, I judge it worth the effort to inquire somewhat more deeply. If perhaps this is not yet granted from so few examples duly observed up to now, I hope that others will follow us who will, without doubt, cultivate so useful a matter more thoroughly. [Margin: Autor ſtatui[t?] hypotheſi illi quadantenus ſubveniri poſſe.] *The author holds [?] that that hypothesis can be helped to some extent.* Meanwhile, however, I shall with good heart disclose what I think and what I have found in this business so far, and also how that hypothesis can be helped, and commit it to others to weigh further.

Before we come down to that, however, let us compare the daily motion of the other two comets from the hypothesis with the motion detected from the observations. Since the hypothesis or ephemeris by tangents of these comets, namely those of 1664 and 1665, has already been constructed and published by various distinguished men (as I was just saying), Cassini, Auzout and Father Pardies, I could, in your opinion at least, my reader, have spared myself this labour. But because I was thoroughly persuaded that, if more certain and more accurate observations were supplied, a more exact daily motion would

certainly also result from that hypothesis according to tangents [Margin: Quare Autor ipſemet Ephemeridem condere ex ſuis obſervationibus ſuſceperit ?] *Why the author himself undertook to build an ephemeris from his own observations.* — as everyone will readily grant us, since the distinguished Auzout himself, in the *Ephemeris of the Comet of 1664*, is of the same opinion; for he says: "And although my observations were made only with threads, rulers, set squares and staffs, I was obliged to content myself with them. If I had had a more suitable place and the large instruments necessary to make [Margin: Cl. Auzoutius ſibi perſuadet, datis exquiſitis obſervationibus, poſſe motum Cometæ,] *The distinguished Auzout is persuaded that, given exquisite observations, the motion of the comet can*[687] very exact observations, I would have made them, and I do not doubt that they would have helped me to hit the mark better than I shall." [Margin: juxta Tangentes omninò etiam accuratè inveſtigari.] *be investigated altogether accurately, even according to the tangents.*

But in truth I have at length learned from many examples that, even if you apply to this hypothesis the most perfect observations of all, drawn from the sky itself with the largest and most exquisite instruments, you will still never in any way elicit the daily motion by the tangents perfectly and correctly (except by some chance accident, in certain comets, of which more later), as the matter rightly demands, so that it agrees altogether precisely with the motion found from the observations themselves by geometrical calculation. [Margin: Etiamſi dentur omnium accuratiores obſervationes, tamen nullo modo juſtè, dictâ methodo determinabis motum Cometæ apparentem, nedum verum.] *Even if observations more accurate than all others are given, you will still in no way correctly determine, by the said method, the apparent motion of the comet, let alone the true one.*

This spurred me on all the more to examine this same comet of 1664 and its daily motion no less from my own observations, in the same way, although it has already been diligently examined by three eminent men by means of the tangents. I relied on the surest hope that, since I was now taking up for the hypothesis entirely different observations, which beyond all doubt those men had neither seen nor had at that time, I would find an entirely different daily motion: one, namely, that would come somewhat closer to my observations than the daily motion found by the distinguished Cassini, Auzout and Father Pardies. But see now: although all of us used entirely different observations for this hypothesis, you will soon perceive what nevertheless came of it. [Margin: Ex diverſis plan[[è/e]] obſervationibus diverſi Autores, poſt

[687] The quotation from Auzout, from Et quoy que to the foot of the page, is printed in French, in italic; it runs on overleaf, and the Latin sentence that it interrupts (beginning with But because I was thoroughly persuaded) has not reached its main clause at the foot of this page. The side-note beside the end of the page also runs on overleaf. In body line 4 the page prints the name as Anzoutius; in lines 35–36, line 41 and the side-note it prints Au-zoutio and Auzoutius.

maximam velocitatem, ferè eundem motum deducunt.] *From entirely different observations, different authors derive almost the same motion after the greatest speed.*

For the distinguished Cassini chose, for building that ephemeris, the observations of December 22 and 23 made by the distinguished Montanario [Geminiano Montanari]; the Reverend Father Pardies, observations of December 18, 20 and 22, made by himself or by others; I laid down as the basis those of December 15, 18 and 21, obtained from the sky by me myself; but which observations the distinguished Auzout took, or of what kind, has not indeed become known to me. I think, however, that he too without doubt fell upon observations entirely different from ours, so that each of us used quite individual observations for the same matter and for carrying out the same calculation in the same way. All of these, certainly, if they are examined more scrupulously, did not agree with one another to the minute, as must readily be granted. And yet, however plainly we disagree in the data, it will now be shown with what precision we nevertheless agree in that daily motion found from the same hypothesis by the tangents, leaving aside that the perigee of this comet was not fixed by all of us at exactly the same time. For the distinguished Cassini (if I am not mistaken) places it on the 29th at $1^h\ 20^m$ before noon; the distinguished Auzout (as may be read in the distinguished Cassini, in his *Theory* of this comet, chapter 18, page 51) on the 29th at 8^h after midnight; the Reverend Father Pardies on the 29th at $9^h\ 59^m$ in the morning; but I fix it on the 29th at $8^h\ 29^m\ 30^s$ in the morning. [Margin: Cl. Caſſinus, Auzoutius, P. Pardies & Autor, quà Perigæum inter ſe minimè conveniunt.] *The distinguished Cassini, Auzout, Father Pardies and the author by no means agree with one another as regards the perigee.* So it is beyond all doubt that we differ in the hours, although the perigee is almost the principal foundation on which this hypothesis rests. Admittedly, the distinguished Auzout agrees with me fairly precisely in this respect, more than the others, so that one may gather that he too can thereafter agree with us as regards the motion more accurately than the rest; and indeed, if we follow the reasoning, far more precisely than the Reverend Father Pardies, who departs from our calculation by as much as an hour and a half in the perigee.

But in fact the very opposite happens: those who disagree most widely among themselves in the perigee agree with one another much more precisely: name- [Margin: Illi Autores, qui longiùs iner ſe quà Perigæum diſſi-] [recte: inter] *Those authors who, as regards the perigee, more widely among themselves dis-*[688] ly, the distinguished Cassini differs from the distinguished Auzout in the perigee, if I am not mistaken, by almost seven whole hours; and nevertheless, as regards the daily proper motion, they agree so exquisitely that they hardly

[688] The quotation from Auzout, printed in French and in italic, ends in the second line of this page; the Latin sentence that it interrupts on the preceding page (beginning But because I was thoroughly persuaded) is not taken up again, and the page goes on with a new sentence. The page sets aliis habitas (made by others), hæc, cæteris and illi in italic. In the last side-note the page prints in- at a line-end and er at the start of the next line, without the t of inter; the note runs on overleaf, as does the last sentence of the page.

depart from each other by even a single minute, as can be seen on page 60 of Cassini's *Theory of the Motion* [Theor. motus Casſ.]. [Margin: dent, accuratiùs, quà motum, conveniunt.] *agree, agree more accurately as regards the motion.* In the middle, it is true, around the greatest speed, they differ from each other by about 15 or 20 minutes; but at the greatest speed they again agree closely, so that the same motion is set by both at 13° 23′ or 24′. [Margin: Cl. Caſſinus & Auzoutius in motu Cometæ 1664 certo loco ab invicem recedunt.] *The distinguished Cassini and Auzout depart from each other at a certain place in the motion of the comet of 1664.* In the rest of the motion, however, both following and preceding, they do not depart from each other by even the smallest seconds, all the way to the last of January, whose motion each of them gives as 13′.

By contrast, the Reverend Father Pardies, like me, departs most evidently from the distinguished Cassini and the distinguished Auzout in the daily motion, especially for about 15 days on either side of the perigee, where at a certain place we are removed from them by 30′, 40′, indeed by 1° 22′, namely on 1665 January 2. [Margin: R. P.Pardies & Autoris calculus,à Cl.Caſſini & Auzoutii numeris ampliter deviat.] *The calculation of the Reverend Father Pardies and of the author deviates widely from the figures of the distinguished Cassini and Auzout.* On the other hand, although an hour and a half lies between the Reverend Father Pardies's perigee and mine, and although we have the benefit of different observations besides, you will clearly see — as appears from our calculation, under column 6, and from that of the Reverend Father Pardies set out on page 74, near the end of his *Dissertation on the Motion and Nature of Comets* [Diſſert.ſuæ de Motu & Naturâ Com.] — that we nevertheless correspond so exquisitely as regards the daily motion of all the days, beginning from the point of speed up to February 6, that we hardly differ by a single minute, and that around the greatest speed. [Margin: Etiamſi R.P. Pardies & Autor, ratione Perigæi diſſentiant, in motu tamen mirum in modum conſentiunt.] *Although the Reverend Father Pardies and the author disagree in respect of the perigee, they nevertheless agree remarkably in the motion.* At this, truly, I wonder greatly, quite at a loss as to what reason this is to be ascribed to: that, namely, from such different observations, with a quite different perigee laid down, an altogether equal daily motion should be elicited by each of the two of us by the same method.

Moreover, all four of us very nearly agree in this: that the greatest speed according to this hypothesis comes out above 13°, namely 13° 23′ for the distinguished Cassini, 13° 24′ for the distinguished Auzout, 13° 14′ for the Reverend Father Pardies, and 13° 9′ for me; at the beginning of February, on the other hand, the daily motion becomes 13′ for all of us, or at least 12′. This, however, seems to me most manifestly erroneous, since it is utterly at odds with all the observations set out for anyone in the *Mantissa*. [Margin: Maxima velocitas ex hypotheſi per Tang. non reſpondet genuinis obſervationibus.] *The greatest speed from the hypothesis by the tangents does not answer to the genuine observations.* For the greatest speed, investigated there by us with due and

accurate calculation, was no more than 12° 51′, and the proper motion 8′ at the beginning of February, and on February 4 5′. It must be admitted, though, that my ephemeris according to the tangents comes somewhat closer to the observed values than that of the distinguished Cassini and Auzout. [Margin: Autoris calculus aliquantò propiùs accedit maximæ velocitati cometicæ; progreſſu tamen non minùs in duplo aberrat.] *The author's calculation comes somewhat closer to the greatest cometary speed; in its progress, however, it goes astray no less, by double.* For even where the greatest discrepancy of all is found, namely around the greatest speed, it departs by no more than 18′, whereas according to the calculation of the said authors it departs by more than 50′; and at the beginning of February it exceeds the proper motion drawn from the observations by only 5′. Yet this seems far too much, since in reality the motion at that time was only 7 or 8 minutes; and so the motion from the ephemeris according to the hypothesis exceeds the other, from the observations, almost in a double ratio.

The later comet, that of 1665, was no less computed by the distinguished men Cassini and Auzout according to the course of the tangents. But since they disagree greatly with each other — and indeed around the course of the greatest speed by almost half a degree, and on the remaining days by 50′, 20′ and, successively, also somewhat less — not [Margin: Autores in eodem Calc[?]lo Cometæ 1665 abundè à vero exorbitant.] *The authors go far astray from the truth in the same [?] of the comet of 1665.*[689] able to refrain, I took on this labour as well, so as to investigate the motion of this comet from our observations according to the tangents; and so I found that I too depart enormously from those authors. With the distinguished Auzout I agree very accurately indeed in the greatest speed, and certainly much more closely than with the distinguished Cassini; on the other hand, in the motion of the following days, in respect of slowness or speed, I depart much further from Mr Auzout than from Mr Cassini. This will be clear to anyone from a comparison of the calculations: Cassini's on page 59 of his *Theory* [ſuæ Theor.], and Auzout's on page 9 of the *Ephemeris* [Ephem.]. Our own calculation, however, we have set out in the preceding table, 782, under the antepenultimate column, and in the penultimate column the daily motion from our observations, pages 33 and 34 of the *Description of the Comet of 1665* [Deſcript. Com. 1665], so that you might recognize the discrepancy of each calculation all the more clearly. [Margin: Quanta ſit calculi diſcrepantia diverſorum Autorum ab ipſis obſervationibus, in Cometâ 1665.] *How great the discrepancy of the calculation of various authors is from the observations themselves, in the comet of 1665.* At the beginning (as indeed it cannot be otherwise) the deviation is only 4 minutes; but as it proceeds it grows more and more, so that

[689] The page sets no italic in the body. In the side-note against lines 13–15 the page prints am - at a line-end, with a space before the hyphen, and pliter at the start of the next line; the word is ampliter (widely). In the side-note against lines 44–47 the fifth letter of the word after eodem is not legible; the context suggests a word for calculation, but the letter is not read. The sentence at the foot of the page runs on overleaf; the word printed as catchword completes it.

by April 20 the motion derived from the tangents already errs by as much as 30′ in defect, just as the earlier comets did in excess. Indeed, if the comet had come into our view on April 30, this discrepancy would have run to 50′. For on that day the hypothesis gives a daily motion of only 56′, but the observations 1° 46′, so that the difference is almost one whole degree. Can such a deviation be pardoned? Judge for yourself, I ask you.

From these examples it is abundantly clear that this hypothesis runs up against the most manifest and indubitable observations, now in excess, now in defect, though in this comet in one way and another, and in that one more or less, according to the position and situation of the trajectory with respect to the ecliptic, the equator, and the motion in longitude and latitude, as we shall point out more fully below. [Margin: Theoria ex Tangentibus modo in excesſu, modò in defectu enormiter peccat, datis licet exquiſitioribus obſervationibus.] *The theory from the tangents errs enormously, now in excess, now in defect, even though more exquisite observations are given.* Hence I am thoroughly convinced that it is altogether impossible, right from the beginning of the appearance of comets, to determine or predict their genuine and appropriate proper motion down to the very minutes by means of that said hypothesis by the tangents, and that from only one or another observation, which often wavers. Nor is it possible once the comet's whole course is finished, however much you may choose and settle on the more accurate of all the observations for carrying out that calculation.

I do not despair, however, that this hypothesis can in part be helped, if we had certain things known beforehand, correctly detected at the outset, before we came to the construction of the theory. [Margin: Autor exiſtimat, poſſe medelam ex parte illi hypotheſi afferri.] *The author thinks that a remedy can in part be brought to that hypothesis.* How it could yet be done most perfectly in every part, I do not yet grasp; but in the course of time, when we obtain more observations of more comets, I certainly grant that it may perhaps be possible for each and every thing to be corrected. For even if nothing else at all stood in the way, it is enough that this hypothesis is founded on a trajectory line that is wholly straight and exempt from all curving. Yet in all comets this line by no means proceeds quite straight, as we have shown most fully in this work by the examples of many comets; rather, the course of the trajectory is curved, or nearly conic, yet in such a way that in one comet or another the path is more curved. [Margin: Quare non ab omni parte.] *Why not in every part.* In this oblique part of the trajectory, which resembles no segment of any circle, I confess that I do not yet fully understand how the motion is to be determined properly and exactly by the tangents.[690]

[690] In body line 21 the words for the most manifest and indubitable observations are set in italic, and in lines 37–44 italic sorts stand among the roman in several words; the change of fount carries no evident emphasis and is not reproduced. The table cited as the preceding table, 782, is cited by the number alone, without pag.

Yet in my judgement this hypothesis can be partly restored as regards the proper motion: namely, if this calculation were undertaken from well-ascertained observations separated from one another by a very long interval, and if at the same time the motion of the nodes [motus Nodorum] — which I now suppose to have been most exactly investigated — were scrupulously taken into account, however extremely arduous it may be to investigate it; especially if at any time the comet has not been duly observed continuously on every single day, as is almost never granted to us in these more northern regions because of the adverse weather. [Margin: Quâ ratione hypotheſis illa reſtitui poſſit.] *How that hypothesis can be restored.* For while I weigh this matter somewhat more carefully, and examine these three more recent comets more closely together with others — from what source this daily motion, derived by the method of that hypothesis from the most thoroughly tested observations, sometimes goes so enormously astray from the truth — I see and find that not the least cause is this: in carrying out this calculation, something is assumed as if certain which in reality is quite otherwise. [Margin: Vnde deviatio hujus hypotheſeos oriatur?] *Where the deviation of this hypothesis comes from.* Namely, that the angle of inclination of the orbit, both to the ecliptic and to the equator, remains, as it were, always of the same size in any comet whatever throughout the whole time of its appearance; and thus, which is the chief point, that there is no motion of the nodes. Yet this opinion is most manifestly false. For in all comets the variation of this angle, and likewise of the motion of the nodes, is very evident, and not rarely runs to a great many whole degrees in a short space of time, as our calculation sufficiently attests in many places. [Margin: Ob motum Nodorum præcipuè dicta hypotheſis vacillat.] *The said hypothesis wavers chiefly on account of the motion of the nodes.* This motion of the nodes, moreover — especially insofar as it is carried against the order of the signs, or according to the order of the signs [ſecundùm Sign. ordinem], or forwards along the course of the trajectory, or backwards against it — to that extent varies the daily motion from the tangents in that assumed straight trajectory now more, now less, according, namely, as this motion of the nodes proceeds now more obliquely, now more directly with respect to the trajectory. I could readily set out and demonstrate this very point more fully and more clearly with some diagram; but enough has been said for attentive scholars: they will easily grasp that everything really is so.

Since, then, in my opinion that motion of the nodes varies and complicates to a remarkable degree the motion produced from the tangents, it is not hard to understand that, once that motion of the nodes is accurately known for each day, this proper motion from the hypothesis can certainly also be corrected not a little — namely in this way: by adding that motion of the nodes of the orbit and the ecliptic to the daily motion found by the tangents, or by subtracting it from that motion. [Margin: Motu Nodorum poteſt quadantenus hypotheſis ex Tangentibus reſtitui.] *By the motion of the nodes the hypothesis from the tangents can to some extent be restored.* Let us therefore make a trial in these three more

recent comets, in which the motion of the nodes has become known to us, I believe, accurately enough from observation and calculation, so that we may see whether the matter succeeds in the said way, and whether the daily motion according to the hypothesis, or the tangents, can in part be brought back and restored. As we have already touched on, I am thoroughly convinced that this cannot be done in every respect, especially in those comets whose motion of the nodes is very swift and is almost equal to the proper motion in its orbit. But why this happens will also be told by us very soon, as well as how a remedy can in some part be brought to comets of this kind.[691]

First, in the comet of 1661, the proper motion from the hypothesis, as is evident from the table above on page 782, departs very greatly indeed from the proper motion from the observations, by almost 50 minutes as it proceeds. [Margin: Cometâ 1661 demonſtratur, poſſe motu Nodorum hypotheſi ſubveniri.] *In the comet of 1661 it is shown that the hypothesis can be helped by the motion of the nodes.* It is, however, partly corrected in this way (since it constantly errs in excess): if the daily motion of the nodes of the orbit and the ecliptic, known to us from Table G on page 741, under column 6, is subtracted from it. For example, on February 13 the daily motion from the hypothesis was found to be 1° 28′, and to that day belongs a daily motion of the nodes of 41′, subtractive [Subt.]; when this is taken away, 47′ remains, while the observations show 49′, so that only 2′ of difference lies between the motion found and the motion observed. Likewise on February 20 the motion from the hypothesis was found to be 1° 16′; when the motion of the nodes, 39′, is taken from it, 37′ remains; the observations show the same motion as 24′. Again, on February 25 the motion from the hypothesis is 1° 7′, and the motion of the nodes 40′; therefore the corrected motion is 27′, while from the observations it is given as 21′. On March 1 the motion from the hypothesis is 1° 0′, the motion of the nodes 45′, subtractive; therefore the motion as limited is 15′, but from observation 19′. Again, on March 15 the motion from the hypothesis is given as 41′, the motion of the nodes as 22, subtractive; therefore the corrected motion is 18′, but from observation 12′. So it is certain that by this method this hypothesis can for the most part be corrected, apart from a few minutes, although otherwise it departs far too much from the observations, by as much as a dodrans [dodrantem], indeed a sextans [ſextantem], in excess. At the very beginning, it is true, where the observations are laid down as the basis of the theory, there (please note) a remedy is not so readily brought to the hypothesis. But why? That too will have to be told shortly, provided we first examine the motion of the two later comets in the same way, to see whether in them too this limitation deserves some place.

Second, help is brought to the comet of 1664 in an easier way still, because its motion of the nodes is much slower — on this express condition, however,

[691] The page prints mox mox, the adverb doubled for emphasis, rendered very soon. In the side-note against lines 29–32 the page prints quadantenus, a form of quadamtenus (to some extent).

that the motion of the nodes has been investigated very precisely; and in comets that is no light matter, as the more experienced know very well. [Margin: Cometæ 1664 motus diurnus ex hypotheſi, pariter motu Nodorum corrigitur.] *The daily motion of the comet of 1664 from the hypothesis is likewise corrected by the motion of the nodes.* But so that you understand rightly: the daily motion according to the tangents derived from my observations and my calculation, and inserted in the table on page 782, and also that of the Reverend Father Pardies, is corrected very well by our motion of the nodes. The ephemeris of the distinguished Cassini and Auzout, on the other hand, departs rather far from our observations around the greatest speed, both before it and after; so we cannot come to its aid as completely as we can to ours and to that of the Reverend Father Pardies. Let us therefore pass it over for now and correct our own, whose greatest speed came out from the tangents as 13° 9′. Since the motion of the nodes was direct, while the proper motion in the orbit was retrograde, the motion was evidently, as it were, drawn back — that proper motion, namely — by just as much distance travelled as the retrogression of the nodes amounted to. [Margin: Et quidem adeò accuratè, ut vix unicum ſcrupulum deficiat.] *And indeed so accurately that it falls short by scarcely a single minute.* Since, then, that motion of the nodes, on the very day on which the comet's greatest speed occurred (as is clear from the table on page 111 of the *Mantissa* of the *Prodromus* [Mantisſæ Prodromi]), was 19′, let it be subtracted from that greatest speed found, 13° 9′, and the motion as corrected and limited becomes 12° 50′; my observations give it as 12° 51′, so that the discrepancy is of no more than a single minute, which in this business is certainly of no importance. Again, on January 9 the motion from our hypothesis by tangents was found to be 1° 54′, and on that day the motion of the nodes, from the said table on page 111 of the *Mantissa*, amount-[692] ed to 4′; when this is subtracted, the motion becomes 1° 50′, which our observations show as 1° 51′. On January 20 the motion from the hypothesis is given as 31′, and the motion of the nodes, from the observations, as 6′, subtractive; there remains a motion as limited of 25′, which the observations [obſetvationes] [recte: obſervationes] themselves show as 26′. On February 1 the motion from the hypothesis is 13′, as all the others also found it, namely the distinguished Cassini and Auzout and Father Pardies; but the motion of the nodes found on that very day is 6′; therefore the corrected motion is 7′, while observation gives 8′. Judge for yourself, I ask you, whether this remedy of ours does not amply satisfy this deficient theory, since

[692] The page sets etiam mox dicendum erit, dummodò priùs (body line 21) in italic, and italic sorts stand among the roman in several words of lines 36–44; the change of fount carries no evident emphasis and is not reproduced. In body line 15 the value of the motion of the nodes, 22, is printed without a minute sign, and the corrected motion beside it is printed 18′. The page prints dodrantem and ſextantem without naming the whole of which they are fractions (three-quarters and one-sixth). The last sentence of the page runs on overleaf; the catchword completes exti- as extitit.

the corrected motion departs from the true motion from the observations by no more than a single minute in any respect.

[Margin: Etiam hâc ratione evincitur motum Cometæ 1664 diurnum, die 4 Febr. haud fuisſe majorem 5 minut.] *By this method too it is proved that the daily motion of the comet of 1664 on February 4 was not greater than 5 minutes.* Since this is so, it is again clearly proved, even from this very hypothesis, that the apparent motion of this comet of 1664 was by no means greater than the motion given by us in the *Mantissa* and demonstrated there most fully by so very many observations: namely, that on February 4 the daily motion was not 12′ or 11′, as the hypothesis by tangents, constructed even from the more correct observations, makes it out to be, but in reality only 5′ [5′ minutorum].

[Margin: In quibus Cometis hæc limitatio per motum Nodorum non habeat locum.] *In which comets this limitation by the motion of the nodes has no place.* Third, as regards the last comet, that of 1665, it too is helped no less in part, but not in every respect: namely, by adding the motion of the nodes to the daily motion from the hypothesis. For since in this comet the motion of the nodes was in general [ferè] faster, especially in its decline [in decurſu], than the proper motion itself in its orbit, this limitation by no means fulfils its promise as yet. [Margin: Quâ viâ calculus ex tangentibus inſtituendus, per motum Nodorum abſolutè reſtitui poſſit.] *In what way the calculation from the tangents, which is to be set up, could be fully restored by the motion of the nodes.* For if, in my judgement, this correction by the motion of the nodes is to be set up properly and precisely, the procedure of this calculation by tangents would have to be approached in a far different way in all comets: not at all from the bare apparent observations — the longitudes, namely, and latitudes [Longitudinibus ſc. Latit.] — and the proper motion as well, as is otherwise the custom in this hypothesis. Rather, necessity would require, first, that this observed apparent daily motion be converted into the true one by adding or subtracting the motion of the nodes, according to the position of each comet's trajectory (which, however, would be very difficult from the very beginning); and likewise, in the same way, the longitudes and latitudes themselves which were to be applied to the theory, since they too are disturbed by the motion of the nodes. And so, as one hopes, if the daily motion were investigated by this method, following the lead of that hypothesis, it would without doubt come out proportioned through the whole duration, just as if it were joined with the motion of the nodes. Then, from the daily proper motion found in this way, if the motion of the nodes were subtracted from it in order for any days, or added to it, according to the comet's course, this proper motion from the hypothesis could (I think) be corrected far more exactly, and indeed uniformly from the very beginning to the end; and this otherwise, from the very outset where the observations are assumed, can in no way be done. For we build the theory on bare observations, that is, on apparent motions (as we did above), and this is mixed with the proper motion. Hence, around those days of the observations assumed, there never arises a discrepancy between the motion of the theory and the motion from

the observations as great as the progression of the nodes. But I leave the rest for others to weigh and examine.

[Margin: Quem in finem autor ea, quæ de hypotheſi Cometar.] *To what end the author those things which concern the hypothesis of comets.* Finally, my Astrophile, do not, I beg you, interpret all that has been put forward so far about this theory built on tangents otherwise than as it was undertaken by us; above all since, for this reason, this matter somewhat

[Margin: per Tang. dicta fuére, admonuerit.] *… were said by tangents, has given warning.*

more fully has been discussed by me, so that those to whom this business of the motion of comets is not so very thoroughly known should not attribute far too much to this theory, nor judge and examine the observations of others by it. For it has been more than sufficiently demonstrated that this very hypothesis, in all comets, as far as the daily motion is concerned, deviates quite evidently, and indeed sometimes more than is fair, from the sky itself and from exact observations. But I also wished to indicate and show in some measure to the more skilled investigators of celestial things in what part this theory can be helped, so that they might devote their effort, in the course of time, to finding and uncovering something more solid (and I by no means despair that this may indeed happen), by which this hypothesis might be brought, with God and with time [cum DEO & die], to greater perfection and certainty, and so the cometographic study [Studium Cometographicum] might not fail [non nequeat] to be built up, enlarged and adorned more and more.

[Margin: In magnis & voluiſe ſat eſt.] *In great things it is enough even to have willed.* In accordance with the powers of my mind, and with the eagerness for these sublime celestial contemplations that I have carried in my heart from my very youth, I have contributed as much to this business as I was able to accomplish in view of time, business and observations. Without prejudice, however, to all others, I have set out our opinion both on the motion of comets and on their origin and passing away [Ortum & Interitum], and also on very many questions overflowing from this most ample material; and I have elucidated and established our hypothesis, as it seems to me at least, by sound observations, as many as it was permitted to obtain. The rest I leave to the more learned, and above all to our most illustrious Royal Society [Illuſtriſſimæ Regiæ Noſtræ Societati], to work out, and also these things of ours, such as they are, to be examined, weighed and refined more and more. But to God Most High, the Supreme Artificer of these immense works, I give and feel from my whole heart the most humble and undying thanks, that He has so far most mercifully granted us life and strength to toil through this hard labour at last to the Glory and Honour of His Divine Name, and to bring it out into the light. And we pray from the heart that He may further prosper our remaining celestial labours [Operas], still somewhat more sublime, undertaken for the good of astronomy [Rei Aſtronomicæ], and bring them to a good end.

Johannes Hevelius, Cometography, Book Twelve [JOHANNIS HEVELII COMETOGRAPHIÆ LIBER DUODECIMUS,]

Presenting the History of All Comets Recorded by Historians, Philosophers and Astronomers from the Creation of the World until Now [Exhibens Omnium Cometarum, à Mundo condito hucusq3, ab Hiſtoricis, Philoſophis, & Aſtronomis annotatorum HISTORIAM.]

Preface [Præloquium.]

[Margin: Quâ via ad Scientiam Naturalem promovendam perveniatur.] *By what route one may arrive at the advancement of natural science.* Experience and unwearied contemplation, together with close inquiry, contribute most of all, in everyone's reckoning [omnium calculo], to the knowledge of natural things and to penetrating and exploring their secrets more and more. Therefore, since in the eleven preceding books of this work we have treated thoroughly, according to our modest capacity [pro noſtro modulo], that sublime and arduous, indeed most intricate, material concerning comets — both what seemed to bear on their origin and passing away and what seemed to bear on their motion — I am thoroughly convinced that the whole of cometography can be elucidated and strengthened not a little, [Margin: Exemplis atq; Obſervationibus Cometographiæ ſubvenitur.] *Cometography is helped by examples and observations.* if there were also added to this work a history of all comets, following the series of the times, from the year, namely, about 2300 before the birth of Christ (when authors first began to record comets), up to now [hncusque] [recte: hucusque]. This is above all to the end that not only our own hypotheses, but also the so very diverse hypotheses of others, may be the more readily examined, elucidated and established, or else wholly refuted and overthrown, with the help of so very many observations made over many past ages [à multis retroſeculis].

[Margin: Cur Autor Hiſtoriam Cometarum conſcripſerit ?] *Why has the author written a history of comets?* I do not indeed deny that histories of comets of this kind were compiled and published long ago by some: for instance, to pass over others for the moment, by Antonio Myzaldo [Antoine Mizauld], Ludovico Lavathero [Lavatherus], Abrahamo Rockenbachio [Abraham Rockenbach] and Henrico Eckstormio [Heinrich Eckstorm]. But since most of them, not to say almost all, directed their writings to this end (being, that is, wholly convinced that comets are messengers of calamities, of the death of kings and princes [Regum Principumque interitus], of the change of kingdoms and of great disasters), that they might come to the aid of astrology and cultivate it, and make firm and fixed, by whatever means they could, the opinion they had once seized upon about the adverse significations of comets (although it must be admitted that this was sometimes done quite lamely [ſatis frigidè], and with examples less than fitting), and also stir up and instil in people a fear, though in my opinion an empty one — I was all the more ready to compose a history

of comets likewise. I did so not, indeed, with the intention of bringing help to the art of divination [Arti Divinatoriæ], but above all to astronomy and to cometography.

[Margin: Quænam Autor in hâc Hiſtoriâ præcipuè attenderit ac notaverit.] *What the author has chiefly attended to and noted in this history.* For this reason, in this catalogue of hairy stars [Crinitorum Siderum Catalogo], I have entirely removed and rejected all those histories and examples which I judged to pertain to significations, or outcomes, and to the judicial art [Artem Judiciariam], taking pains to collect and record purely astronomical matters: above all, whatever I could ever find in the authors about the first appearance of comets, their situation, place, motion and duration, the shape and colour of the head and tail, and other things of that kind. And so that this whole business might be carried out the more successfully, and placed the more clearly before everyone's eyes, I was by no means content with only what I found in the authors just cited. Rather, I did not find it burdensome first to go through myself all those histories that others have mentioned, and then also to leaf through, search and read through a great many historians (as is clear from the catalogue prefixed to this work) and the writings of other authors on this subject from which I supposed I could gather at least something on the same matter; so that I would not fail [ne non] to bring forward the very words of the writers and historians, and would omit nothing at all that might serve our history and illuminate it. For that reason I have also added brief notes and remarks here and there, where the matter needed unravelling and explanation.

[Margin: Quid cauſæ fuerit,cur Laudabilis Antiquitas nobis de Cometis plura non reliquerit?] *What was the reason that praiseworthy antiquity did not leave us more about comets?* It were to be wished, however, that the ancient philosophers and historians had, from the very first beginning, described comets somewhat more accurately, and had handed down to us their course, and whatever bore on astronomy, point by point and with greater diligence. Without any doubt the moderns [Recentiores] would by now have penetrated and uncovered, as they wish, things far deeper in cometography. But alas! not only the older philosophers, astronomers and historians before the birth of Christ, but also the rest after his nativity, up to roughly the times of Regiomontanus and Apian [Regiomontani Appianiq́ue], were scarcely concerned, and only lightly, with this matter of hairy stars, being wholly persuaded by the Peripatetic school that all comets are sublunary meteors and things of lighter importance, in no need of fuller recording. Hence they committed to writing very little about hairy stars [Stellis Crinitis], indeed almost nothing accurate; moreover, they recorded very few comets (although I am fully convinced that far more shone forth in the earliest times); and where they did make mention of any one among the rest, they scarcely, barely at all [vix ac ne vix], duly added the year in which it appeared, not to say the month, much less the day, almost all the other things that belong to a genuine history being neglected. [Margin: Plurimi Cometæ indigent correctione.] *Very many comets need correction.* From this it has come

about that not a few of the comets, both before and after the Christian era, up to the year 1400 and 1500, have scarcely been properly recorded as regards their true appearance.

For authors not infrequently pass it off as certain that two different comets shone in one year, when in reality only a single one shone: above all when a morning comet had become an evening one, or conversely an evening comet a morning one. For this reason I would not dare to promise for certain that in this History of ours, too, no comet has been assigned to some other year than the one to which it perhaps should have been. Beyond all doubt I have likewise sometimes set down two in place of one, owing, that is, to the defects in the records of my predecessors [annotationum Prædeceſſorum]. For although I have applied every effort to avoid such errors as far as possible, I have nevertheless been unable to reconcile the historians and authors as a whole completely, and so to restore each comet to its own true year, as can be seen here and there from our remarks.

[Margin: Recentiores, ad Cometarum phænomena fuerunt attentiores.] *The moderns have been more attentive to the phenomena of comets.* From the year 1472, however, in which the most ingenious Regiomontanus was the first to begin observing a comet properly as regards its course [quà meatum], comets were described and sketched somewhat more exactly by his successors as time went on; and indeed most exactly of all by the incomparable Tycho, using very large and very exact instruments. This is evident from the comet of the year 1577, to say nothing for the moment of the others: he certainly detected and noted with scrupulous care every single one of its phenomena that ought to and could be detected, so that in this way he might at the same time, as it were, pave the way for posterity and hand on the torch for undertaking and carrying out observations by the same method. Very many energetic investigators of celestial things then also entered upon this path, not without fruit, to such an extent that most of the more recent comets after Tycho Brahe [Tychonem Brahæum] have up to now been described and drawn far more precisely, both as regards the shape of the head and tail and as regards their course. And so from that point — from the year 1500, that is — it has fallen to us to construct this History of Comets of ours much more clearly and fully as well than at its beginning. Moreover, we undertook this labour all the more eagerly, the less the often-mentioned history had been properly and duly continued since that time, not to say sufficiently and fully carried through.

[Margin: Hiſtoriam poſteriorum Cometarum Autor pleniùs expoſuit.] *The author has set out the history of the later comets more fully.* Accordingly, for the benefit of cometographic and astronomical study, it seemed best to work out all the comets from the year 1472, that is, somewhat more fully, so that I might set before anyone in summary, as if at a single glance, the principal records and the more notable phenomena of the rest, as ever detected in comets by the leading authors and astronomers and handed down to memory. And since these things have been gathered by us not without great labour and

expenditure of time, I do not doubt that they will be welcome to philosophers, astronomers, cometographers, and also to any inquirers into sublime things. But if, kind reader [Benigne Lector], I have not fully satisfied you — as I readily concede — I ask you most dutifully to pardon me for it, and to ascribe it to the manifold occupations, public as well as private, by which we are always distracted [nunquam non diſtringimur]. Meanwhile, enjoy these things, and continue to favour our Uranian studies and contemplations [Uranicis noſtris Studiis, ac contemplationibus].

History of Comets before the Birth of Christ [Hiſtoria Cometarum ante natum Chriſtum.]

Year of the World 1656. Before the Birth of Christ 2292. [Anno Mundi 1656. Ante natum Chriſt. 2292.]

In the year of the world 1656, three days before the death of Methuselah [Mathuſalem], a comet was seen by the whole world in the dodecatemory [dodecatemorio] of Pisces. It traversed [percurrrit] [recte: percurrit] the 12 signs of the heavens in the space of one month, and on April 16 it vanished again. The Flood followed immediately after it, etc. Rockenbach.

According to Calvisius [Calviſium] and Helvicus [Helvicum], the Flood fell in the year of the world 1656, 2292 BC.

[Margin: Cometa totum Signiferum percurrens.] *A comet running through the whole zodiac.* In the year of the world 1657, that is, 2312 before the birth of Christ, when Noah [Noha] was 600 years old, the Flood overwhelmed the whole earth. A comet then appeared in Pisces, under Jupiter, and in the space of 29 days it passed through all the signs of the zodiac, as D. David Herlicius reports in the *Description of the Comet of 1607* [Deſcript. Com. 1607.]; and Heinrich Eckstorm [Henricus Eckſtormius] in the History of Comets [Hiſtoriâ Comet.].

Year of the World 1944. Before the Birth of Christ 2191. [Anno Mundi 1944. Ante natum Chr. 2191.]

[Margin: Cometa quadrantem Zodiaci curſu ſuo abſolvit.] *A comet completes a quadrant of the zodiac in its course.* In the year of the world 1944, 288 years after the Flood, a comet resembling the nature of Saturn was seen in Egypt, near Alcairum [Cairo], in the dodecatemory of Capricorn, and in the space of 65 days it traversed three signs in the heavens. The confusions of tongues [confuſiones linguarum] followed it. Rockenbach.

According to Calvisius [Calviſ.], the confusion of tongues occurred in the year of the world 1757, 2191 BC.

In the Year 1930 or 1920 BC. [Anno ante Chr. 1930 vel 1920.]

[Margin: cometa 22 dies duravit.] *The comet lasted 22 days.* In the year of the world 2018, in Abraham's 70th year, a comet appeared in the dominion of the Chaldaeans, in the sign of Aries, and shone for 22 days. A great dearth of

grain [annonæ caritas] followed from this, on account of which Abraham was compelled to migrate into Egypt. Rockenbach [Rock.].

Eckstorm reports, from D. Herlicius, that this comet was seen under Mars.

According to Calvisius, Abraham is born in the year of the world 1948, 2000 BC; hence the 70th year of his age falls in the year of the world 2018, 1930 BC. But only in the year of the world 2023, 1925 BC, in Abraham's 75th year of age, is he called out of Haran. The dearth of grain occurred much later. Perhaps the 80th year of Abraham's age would fit better.

Year of the World 2128. Before Christ 1820. [Anno Mundi 2128. An. Ch. 1820.]

In the year of the world 2128, in the fifth year after the death of Abraham, a comet appeared in the sign of Leo [♌] for the space of nine days. It signified great changes and calamities to mortals, about which Serapis and Osiris, gods of the Egyptians, had earlier made many predictions to the people. This comet, too, was followed by another dearth of grain, in the time of Isaac [Iſaaci]. Rockenbach [Rockenb.] and Eckstorm, from Herlicius's *Description of the Comet of 1607*.

According to Calvisius and Helvicus, the fifth year from the death of Abraham falls in the year of the world 2128, 1820 BC.

Year of the World 2230. In the Year 1718 BC. [Anno Mundi 2230. Anno ante Chr. 1718.]

In the year of the world 2230 a comet (as many approved authors determine about this date, from many conjectures), which Pliny the Elder [Plinius] also mentions in book 2, chapter 25 [l.2 c.25], appeared fiery, in the form of an imperfect circle and one rolled in upon itself, with its head representing a globe, terrible in aspect; and Typhon, from the king [à Régе] at that time in Egypt who held power, it was named.

Afterwards a seven-year dearth of grain followed in the time of Joseph [Joſephi], in the year of the world 2237. Calvisius places the migration of Jacob [Jacobi] into Egypt in the year of the world 2238, 1710 BC.

Note: Rockenbach here does have the year of the world 2453; but that there is an error in the figures is very plain from what follows, when he says: "Afterwards, in the year 2237, a dearth of grain followed, etc." This date, 2453, therefore seems to belong to the following comet. For the German rhymes [Rithmi … Germanici] give the year 2230.

[Margin: Cometa igneus, inſtar rotæ.] *A fiery comet, like a wheel.* The peoples of the Ethiopians and of Egypt came to know a dire one, to which the king of that age, Typhon, gave the name: fiery in appearance and twisted like a coil, grim also to look upon, and not so much a star as, more truly, a fiery knot. Pliny, book 2, chapter 25 [Lib. 2 cap. 25.]. Heinrich Eckstorm [Hinr. Eckſtormius] moves this comet to the year of the world 2237. For he says: "In the year of the world 2237 a comet appeared over Arabia like a wheel, near Sagittarius, under Jupiter." From Herlicius.

1495 BC. [Ante Chriſtum 1495.]

In the year of the world 2453, as some would have it, a comet was also seen in Syria, Babylonia and India, in the sign of Capricorn [♑], in the form of a wheel, at the time when the children of Israel set out from Egypt into the promised land. Rockenbach [Rockenb.]. Calvisius places the departure [Exortus] of the Israelites in the year of the world 2453, 1495 BC.

About 1200 BC. [Ante Chriſtum 1200 circiter.]

[Margin: Cometa ab Aſſyriis obſervatus.] *A comet observed by the Assyrians.* In the year of the world 2770, in the month of August, a comet terrible to look upon was seen by the Assyrians in Gemini [♊]. It was followed by the death of a most impious king named Amenemos. A long and wretched war arose over Helen [Helenam]; Troy was taken in the year 2783. Rockenbach. According to Calvisius, Ammenemes, king of Egypt, dies in the year of the world 2736, 1212 BC. Helen is carried off by Alexander, son of Priam, in the year of the world 2755, 1193 BC. Troy is taken in the year of the world 2767, 1181 BC.

1100 BC. [Ante Chriſtum 1100.]

In the year of the world 2795, while Teutanus [Teutano Rege] was king of the Assyrians and held power, a comet blazing for 43 nights under the sign of Aries [♈] was seen by the whole of Greece. In the time of Samson [Samſonis]. Rockenbach.

479 BC. [Ante Chriſtum 479.]

[Margin: Cometa inſtar cornu incurvatus.] *A comet curved like a horn.* And in the age of these men themselves (Anaxagoras and Democritus), histories record a comet for the first time, so far as I know: namely, when Xerxes moved from Sardis [Sardibus] against the Greeks, or, as Pliny reports, when Greece fought it out at Salamis [Salamina]. This happened in the last year of Olympiad 76 [Olympiad. 76], in the year of the world 3484, in which same year battles were fought at Thermopylae [Thermopylas] and Artemisium [Artemiſiam] with differing outcomes. It was called Ceratius, because it was curved like a horn. An eclipse of the Sun, which is described in the histories, had also gone before it at that time. Prætorius.

According to Calvisius, Xerxes moved from Sardis and fought with the Greeks at Salamis in the year of the world 3469, 479 BC, in the first year of Olympiad 75 [Olymp. 75 anno 1.]. Calvisius judges the eclipse of the Sun that is recorded at that time to have been supernatural and extraordinary. Rockenbach places this comet in the year of the world 3458, 478 BC. Lycosthenes, however, refers it to the year of the world [A. M.] 3385, 482 BC [ante Ch. 48 2], on page 63, though he makes the following two much older. Eckstorm, on the other hand, moves the same comet to the year of the world [A.M.] 3489.

465 or 430 BC. [Ante Chriſtum 465 vel 430.]

[Margin: Ingens Cometa per 75 dies fulſit.] *A huge comet shone for 75 days.* A little before the beginning of the Peloponnesian War, after sunset, a huge comet was seen for 75 continuous days. Soon so great a force of winds arose that a whirlwind carried off a stone the size of a wagon, torn from a cliff and lifted on high, until, brought down to a city of Thrace, Aegospotami [Ægoſpotamos], it was popularly believed to have fallen from the sky. Anaxagoras foretold that storm. This comet is mentioned by Aristotle, by Plutarch in the *Lysander* [Plutarch. in Lyſandr.], by Pliny the Elder, book 2, chapter 25 [Plin. l. 2 c. 25.], and by Eberus and Peucerus; Mizauld [Mizaldus], on page 184, assigns it to the Martial ones [ad Martiales].

For when, too, that stone which is shown at Aegospotami fell from the air — it had been lifted by the wind and fell in the daytime — a comet was likewise blazing on those nights. *Meteorol.* book 1, chapter 7, p. 331 [Lib. 1 Meteorol. cap. 7 p. 331.]. Aristotle [Ariſtotel.].

Charimander, in the book he composed on comets, says that a great and unusual light in the sky, the size of a large beam, was seen by Anaxagoras, and that it shone for many days. Seneca, book 7, chapter 5 [Senec. l. 7 c. 5.].

According to Calvisius the stone fell at Aegospotami in the year of the world 3483, 465 BC, in the 2nd year of Olympiad 78 [Olymp. 78,anno 2]; but the Peloponnesian War began in the year of the world 3518, 430 BC, in the 1st year of Olympiad 87.

[Margin: Cometa colore igneus.] *A comet fiery in colour.* In the year of the world 3537, Olympiad 88, in the first year of the Peloponnesian War, a comet appeared, showing a fiery colour after sunset and having the nature of Mars [♂], and it blazed for 75 days. Rockenbach.

Lycosthenes, on page 49, refers this one to the year of the world 2881, 1082 BC; but on page 75 he refers the fall of the stone at Aegospotami [Ægoſpotomos] to the year 464 before the birth of Christ [ante C. N.].

411 or 360 BC. [Ante Chriſtum 411 vel 360.]

[Margin: Cometa Septentrionalis.] *A northern comet.* When Eucleo was praetor at Athens [Eucleo Athenis Prætore], a little before the very heavy defeat that the Athenians suffered in Sicily (which happened in Olympiad 92, on the testimony of Plutarch in the *Lysander* [in Lyſ.], etc.), a comet was seen in the northern part of the sky, as Aristotle states, book 1 of the *Meteor.*, chapter 6; Eberus, Peucerus.

But while Eucleo, son of Molon, ruled at Athens [Imperante Athenis Eucleo,Molonis filio], a hairy star [ſtella crinita] appeared toward the north, in the month of Gamelion (January), with the Sun moving near the winter tropic [Tropicum brumalem]; book 1 of the *Meteor.*, 6.

According to Calvisius the defeat of the Athenians in Sicily occurred in the year of the world 3537, 411 BC, Olympiad 91, year 4, when Cleocritus or Clearchus was archon at Athens [Archonte apud Athenienſes, Cleocrito vel Clearcho]. Calvisius, however, has no archon Eucleem [Eucleem verò

Archontem]. Mizauld, book 1, chapter 11 [l. 1, c. 11], taking the word Eucleou as a common noun [pro appellativo], seems to interpret Aristotle's words thus: under Molon, the most glorious prince of the Athenians, another comet was seen, etc., in the month of January, near the winter tropic, while the Sun was staying there. Eckstorm refers the same comet to the year 412 BC, Olympiad 92; but according to Calvisius, Molon was archon in the year of the world 3588, in the 3rd year of Olympiad 104, 360 BC. Rockenbach refers the same comet to the year of the world 3553, Olympiad 92. Lycosthenes, on the other hand, moves this comet to the year of the world 3553, 410 BC.

371 BC. [Ante Chriſtum 371.]

For that great comet too, which appeared in Achaia [Achajâ] around the time of the earthquake and flood, flashed out from the equinoctial west [ab occaſu æquinoctiali]. Shortly after [Paulò poſt]; Great star, which we mentioned before, appeared in winter, in a hard frost and with a clear sky, in the evening, under the archon Aristaeus [ſub Ariſtæo Archonte]. On the first day it was not seen, because it had set before the Sun; but on the following day it was seen, as far as that was possible. For it left the Sun at the smallest distance possible, and soon set. [Margin: Cauda hujus Cometæ ad tertiam usque cœli partem protenſa fuit.] *The tail of this comet stretched as far as a third part of the sky.* It extended its radiance as far as a third part of the sky, like a leap [inſtar ſaltus]; for this reason it was also called the Road [Viâ]. It rose as far as the belt of Orion, and there it vanished. Aristotle [Ariſtot.], *Meteor.* book 1, 6 [l. 1 Meteor. 6.].

Callisthenes [Calliſtenes] reports that such was the appearance of the long fire before the sea hid Buris and Helice. Aristotle says that it was not a beam [trabem] but a comet. Because of its excessive heat, however, the fire did not appear scattered; but as time went on, when it was now blazing less, its proper face as a comet was restored to it. In this fire there were many things indeed worth noting, yet none more so than this: that as soon as it shone in the sky, the sea was at once over Buris and Helice. Seneca, *Natural Questions* book 7, chapter 5 [Senec. l. 7 Nat. Quæſt. c.5.].

Just as this man (Ephorus the historian) says of the comet that was watched by the eyes of all mortals, since it drew after it the outcome of a huge event when by its rising it sank Helice and Buris, that it split into two stars — something no one besides him has reported. Seneca, book 7, chapter 16 [Senec. l. 7 c. 16.]. According to Calvisius, the earthquake and flood of Achaia [Terræ motus & Inundatio Achajæ], by which Buris and Helice are swallowed up, happened in the year of the world 3577, 371 BC, Olympiad 101, year 4, when Asteius was archon at Athens [Archonte Athenis Aſtejo]. Lycosthenes refers this one to the year of the world 3271, 692 before the birth of Christ, Olympiad 21, year 4, on page 57; but on page 85 he refers the flood of Bura and Helice [Buræ ac Helices] again to the year 378 BC.

354 BC. [Ante Chriſtum 354.]

[Margin: Cometa hirſutus in formam haſtæ mutatus.] *A shaggy comet changed into the shape of a spear.* In the year of the world 3609, in which Alexander the Great was born and the Temple of Diana of Ephesus was burned, Olympiad 106, in the year of the City of Rome 987, a comet that was hairy at first — or, as some would have it, resembling the shape of a shaggy beard — was first seen in Leo [♌], but shortly afterwards it changed into the shape of a spear. Rockenbach [Rockenb.].

We read of a comet recorded by Pliny the Elder [Plinio] which, when it had the form of a mane [Jubæ effigie], was changed into a spear, in the year of the City 398, of the world 3610. In the following year Alexander the Great [Alex.M.] was born, who afterwards, in the year 3629, gained the kingdom of Macedon. Prætorius. According to Calvisius, the year of the City 397 coincides with the year of the world 3594, 354 BC, Olympiad 106, year 1, the very year in which Alexander the Great [Alexander M.] was born. Lycosthenes, however, records the same comet at the year 354 BC, and Eckstorm at 355 BC.

339 BC. [Ante Chriſtum 339.]

[Margin: Cometa matutinus juxta Æquatorem apparuit.] *A morning comet appeared near the equator.* In the year of the world 3624 (some, from Justinus [Juſtino], think it is 29) or when Alexander began to reign, in year 4 of Olympiad 109, 339 BC, when Nicomachus was praetor at Athens [Nicomacho Athenis Prætore], a comet appeared near the equinoctial circle, at 19° of Sagittarius [in 19 Gr. ♐], blazing for 19 days. Rockenbach [Rockenb.]. Likewise, when Nicomachus was archon at Athens, a comet appeared for a few days near the equinoctial circle, never rising in the evening. Aristotle, *Meteor.* book 1, chapter 7 [l. 1 Meteor. c. 7.]. According to Calvisius [Calviſ.], year 4 of Olympiad 109, 339 BC, and the praetor Nicomachus fall in the year of the world 3609; but Alexander acceded only in the fifth year after, to the kingdom. Lycosthenes, however, and Eckstorm as well, refer this comet to year 4 of Olympiad 109.

220 BC. [Ante Chriſtum 220.]

In the year of the world 3743, 220 BC, a comet appeared for 22 days in Aries [♈]. After this, very many wars followed in Gaul; Seleucus, king of Asia and Syria, was killed by treachery, and Antiochus the Great [Antiochus Magnus] succeeded him. Rockenbach [Rockenb.].

The Seleucus meant here is Ceraunus, who according to Calvisius is killed in the year of the world 3729, 219 BC, Olympiad 139, year 4.

196 BC. [Ante Chriſtum 196.]

[Margin: Bini Cometæ.] *Two comets.* In the year of the world 3767, 196 BC, two comets appeared at separate intervals [diſtinctis intervallis]: the first of them

shone for a few days in the sign of Capricorn [♑], the second, after two years had passed [biennio elapſo], in the sign of Cancer [♋] for 19 days. Rockenbach.

Note: here perhaps two months [bimeſtre] or two days [biduum] should be read in place of two years [Biennio]; for in the second year after this one the same author has another comet, of a different duration. According to Calvisius, the year 196 before the birth of Christ [ante nat. C.] coincides with the year of the world 3752.

194 BC. Doubtful. [Ante Chriſtum 194 Dub.]

[Margin: Cometa immenſæ magnitudinis per tres ferè menſes fulſit.] *A comet of immense size shone for almost three months.* In the year of the world 3769, 194 before the birth of Christ [Ante N.C.], in the year in which Mithridates, king of Pontus, was born, a comet of astonishing size appeared, blazing for 80 continuous days. Rockenbach, from Lycosthenes and Josephus [Joſepho], *Jewish Antiquities* book 12, chapter 3 [Lib.12 Cap.3.Antiq. Judaicar.].

Note: Mithridates, king of Pontus, who waged wars with the Romans, was born only in the year 130 or 129 BC [A. C.]. Lycosthenes likewise refers this comet to the birth of Mithridates, from Vincentius [Vincentio], book 6, chapter 100 [lib.6. c. 100].

183 BC. Doubtful. [Ante Chriſtum 183 Dub.]

[Margin: Cometa caudâ ſuâ quartam cœli partem ſubtendit.] *A comet subtended a quarter of the sky with its tail.* In the year of the world 3780, 183 before the birth of Christ [anteN.C.], a comet blazing for 88 days, occupying almost a quarter of the sky and surpassing the brightness of the Sun with its own brilliance, appeared by day in the sign of Pisces [♓]; and in rising [ortumq́ue] or setting it took up a space of 7 or 8 hours. The death of Scipio Africanus followed it. Rockenbach.

Scipio Africanus dies in the year of the world 3766, 182 BC [A.Ch.]. But note: this comet seems to be the same one that Justinus reports shone at the beginning of the reign of Mithridates, of which more below. The author then also adds that Mithridates, being skilled in military matters, undertook great wars against his neighbours; but Mithridates, born in the year 3769, was in the year 3780 still a boy of 11 years. Again, Rockenbach seems to have taken this comet from Lycosthenes, who refers this same comet and the beginning of the rule of Mithridates to the year 183 BC [ante Ch.], namely to the year 569 from the founding of the City.

Cornelius Gemma, in *Cosmoc.* book 1, chapter 8 [Coſmoc. Lib. I. Cap. VIII.], has this about the same comet: [Margin: Mira Cometæ claritas atq́; ſplendor.] *The comet's wonderful clearness and splendour.* A very great comet, at the time when Mithridates is born, in the year of the world 3780, 183 BC [ante Chriſt.], which had occupied a quarter of the sky in such a way that the whole seemed to be ablaze on every side; it lasted 80 days. They say that by its splendour the light of the Sun was almost dulled.

174 BC. [Ante Chriſtum 174.]

In the year of the world 3789, 174 before the birth of Christ [A. N. C.], a comet appeared in the sign of Aries [♈] for 32 nights. In this year Philopater, the seventh king of Syria, died, and Antiochus the Noble [Antiochus Nobilis] succeeded him. Rockenbach. Perhaps he means Seleucus, who before Christ

174, in the year of the world 3774, died, with Antiochus Epiphanes [Antiocho Epiphane] succeeding him. In 173 BC [Ante Chriſtum 173], and in the year of the world 3790, a torch [Fax] was seen in the sky at Gabii [Gabiis]; Lycosthenes, from Livy [Livio] and Julius Obsequens [Iul. Obſequens], chapter 64.

168 or 172 BC. [Ante Chriſtum 168 vel 172.]

In the year of the world 3795, 168 before the birth of Christ, when Mutius Scaevola and Posthumius were consuls at Rome [Mutio Scævolâ & Poſthumio Romæ Conſulibus], a comet blazing for 55 continuous weeks was seen together with three Suns. Rockenbach. According to Calvisius, Sp. Posthumius Albinus and Q. Mutius Scaevola are assigned as consuls to the year of the world 3776, 172 BC.

[Margin: Autor exiſtimat non ſpatio 55 ſeptimanarũ,ſed dierum Come tam hunc fulſisſe.] *The author believes that this comet shone for a space not of 55 weeks but of days.* I cannot imagine, however, that this comet shone continuously for a space of 14 months, since none among all the others has ever (so far as I know) lasted so long. Hence I would venture to conjecture that some error lies hidden here, and that this phenomenon was visible not for 55 weeks, as Rockenbach would have it, but for as many days, that is, for almost two months.

166 or 165 BC. [Ante Chriſtum 166 vel 165.]

[Margin: Cometa Hircus.] *The Goat comet.* In the year of the world 3798, of the City 586, 165 before the birth of Christ [anteN. C.], a comet called the Goat [Hircus], as Seneca writes, appeared on September 4 [quarto Septembris] together with an eclipse of the Moon. Then in the following year a burning torch like a comet was seen in Italy. After this Perseus, the last king of Macedonia, is defeated by Aemilius [Æmilio]. Rockenbach. According to Calvisius, the eclipse of the Moon recorded by Livy, and the defeat and captivity of Perseus, fall in the year of the world 3782, 166 before the birth of Christ, the year of the City 585 — that is, one year earlier than Rockenbach has it. In 166 BC, and in the year of the world 3797, a torch was seen in the sky at Anagnia [Anagniæ]. Lycosthenes.

154 BC. [Ante Chriſtum 154.]

[Margin: Cometa breviſsimæ durationis.] *A comet of very short duration.* In the year of the world 3809, 154 before the birth of Christ, a comet was seen for a space of 9 days in the sign of Taurus [♉]. There followed a scarcity of grain [caritas annonæ] and a long war between the Romans and the Carthaginians, Rockenbach. Perhaps the war meant is that of the Carthaginians against

Massinissa [Masſinisſam], to whom the Romans brought help, and afterwards they make war on the Carthaginians themselves: in the year of the world 3798 and 3800, 150 and 148 BC, according to Calvisius.

144 or 145 BC. [Ante Chriſtum 144 vel 145.]

[Margin: Cometa admirandæ claritatis atq;magnitudinis.] *A comet of wonderful brightness and size.* In the year of the world 3819, the year of the City 607, 144 before the birth of Christ, after the death of Demetrius, king of Syria, a comet like the Sun in size and roundness appeared in the sign of Capricorn, blazing for 22 whole days. Rockenbach. Eckstorm, however, moves it to the year 146.

After the death of Demetrius, king of Syria, whose children were Demetrius and Antiochus, a little before the Achaean war, a comet shone out, no smaller than the Sun. At first it was a fiery and ruddy orb, giving out a bright light, enough to overcome the night. Then its size was gradually drawn in [diſtricta eſt] and its brightness faded, and at last it vanished entirely. Seneca, book 7, chapter 15 [Seneca l. 7, c. 15.].

Demetrius, king of Syria, father of Demetrius and of Antiochus Sedetes [Antiochi Sedetis], was defeated by Alexander and pierced with javelins in the year of the world 3798, 150 before the birth of Christ, the year of the City 601. And in the year of the world 3803, 145 before the birth of Christ [ante N.C.], of the City 606, war against the Achaeans is decreed at Rome because of an injury done to the envoys.

In the year of the City 603, of the world 3819, a star burned for 32 days. In the following year Carthage was destroyed by Scipio [à Scipione] and Corinth by Mummius [à Mummio]. Prætorius [Prætor.]. But according to Calvisius this happened in the year of the world 3804, of the City of Rome [U. R.] 607, 144 before the birth of Christ.

When P. Africanus and Laelius were consuls [P. Africano & Lælio Conſ.], 145 before the birth of Christ, in the year of the City 606, at Lanuvium [Lanuvii], between the third and the fifth hour, circles of different colours surrounded the Sun, one with a red line, the other with a glowing white one [rubente alter, alter candente lineâ]. A star burned for 32 days. Julius Obsequens [Iulius Obſeq.].

135 before the birth of Christ. Approximately, or 134. [Ante natum Chriſtum 135. Circiter vel 134.]

[Margin: Puſillus Cometa, qui mirum in modum ſucceſſu temporis crevit.] *A tiny comet, which grew in a remarkable way with the passage of time.* In the year of the world 3829, the year of the City of Rome [Urb. R.] 617, 136 before the birth of Christ, when King Attalus held power in Pergamum [Attalo Rege Imperium in Pergamo tenente], it appeared in Italy, at Praeneste [Prænesſte], together with a burning torch: small at first sight, but a few days later extending itself very widely near the equinoctial circle, toward Jacob's Staff [baculum Iacobi]. Rockenbach [Rockenb.], Eckstorm [Eckſt.].

In the reign of Attalus a comet [Cometes] appeared, moderate at first; then it raised and spread itself and came as far as the equinoctial circle, so that, stretched out to an immense length, it equalled that region of the sky which is called the Milky Way [cui lactea nomen eſt]. Seneca, *Natural Questions* book 7, chapter 15 [Senec. l. 7. N. Q. c. 15.].

It is credible that he is speaking of that Attalus who flourished after the Achaean war, and was so great a friend of the Romans that he made the Romans the heirs of his kingdom, and who began his reign 137 before the birth of Christ and died in the year 133. Within these years, therefore, this portent was seen, says Riccioli. Calvisius reports that Attalus, the last king of Pergamum, came to the throne in the year of the world 3813, of the City of Rome 616, 135 before the birth of Christ, and reigned 5 years. Rockenbach adds here that there are some among the most approved authors who affirm that this comet appeared in the year of the world [M.] 3831, 132 before the birth of Christ, in the sign of Gemini, and burned for 83 nights.

122 before the birth of Christ. [Ante natum Chriſtum 122.]

[Margin: Cometa Sole ferè lucidior, caudam 90 gr. circ. referens.] *A comet almost brighter than the Sun, showing a tail of about 90°.* Celestial portents had foretold, above all, the future greatness of this man (Mithridates). For both in the year in which he was born and in the year in which he first began to reign, a comet star [Stella Cometes] shone at each time for 80 days, in such a way that the whole sky seemed to be on fire. For in its size it had occupied a quarter of the sky, and in its brilliance it had surpassed the brightness of the Sun; and in rising and setting it took up a space of four hours. Justinus, book 37 [Iuſtinus lib. 37.].

According to Riccioli, Mithridates was born in the year 130 or 129 before the birth of Christ, since he was killed in the year 62 before the birth of Christ, when Julius Silanus and Licinius Murena were consuls [Iulio Silano & Licinio Murænâ Conſulibus], and lived 68 or 69 years and reigned 57 years; this, he says, is established from Appian [Appiano]. According to Eutropius [Eutropium], however, Mithridates lived 72 years and reigned 60. Therefore, if 72 years are added to the year 62 before the birth of Christ, the result is the year 134, around which the comet mentioned by Seneca falls, approximately. [Margin: Hic Cometa idem videtur eſſe, quem Seneca Attali tempore recenſet.] *This comet seems to be the same one that Seneca records in the time of Attalus.* Hence the comet that Seneca records in the time of Attalus, and Justinus in the year of Mithridates' birth, will perhaps be the same one; the other comet, however, at the beginning of Mithridates' reign [ſub initium Regni ejusdem], will fall in about the year 122 before the birth of Christ, which according to Calvisius [Calviſ.] is the year of the world 3826, of the City of Rome 629.

111 before the birth of Christ. [Ante natum Chriſtum 111.]

In the year of the world [A. M.] 3853, 110 before the birth of Christ, a comet appeared in the evening for 15 days in the sign of Cancer [in Signo Cancri], together with a splendid light. Shortly afterwards the Cimbri [Cymbri] made an attack on Illyria and put the consul Papinius [Papinium] to flight, and the Ju- gurthine war was begun. Rockenbach [Rockenb.]. According to Calvisius, the year [An.] 110 BC is the year of the world 3838, of the City of Rome [Vrb. R.] 641. But in 111 BC the Cimbri come into Illyricum and rout the consul Papyrius [Papyrium] together with his army.

65 BC. [Ante natum Chriſtum 65.]

[Margin: Cometa ultra tres Menſes conſpicuus fuit.] *A comet was visible for more than three months.* In the year of the world [A. M.] 3879, of the City of Rome [U. R.] 667, 64 BC [ante nat. C. 64], a comet appeared in Virgo [in Virgine], blazing for 94 nights. At this time the civil war between Marius and Octavius [inter Marium & Octavium] arose, etc. Rockenbach [Rockenb.]. Pliny the Elder [Plinius] says that a comet shone when Octavius was consul [Octavio Conſule], that is, in the year of the City 667. Eberus. A star [ſidus] for the most part terrifying, and not lightly expiated: as in the civil disturbance when Octavius was consul, and again in the war of Pompey [Pompeji] and Caesar. Pliny the Elder, book 2, chapter 25 [Plinius l. 2, c. 25.]. These disturbances, which Cinna caused together with Marius [quos cum Mario Cinna fecit], had already begun, according to Calvisius, in the year of the world 3863, 85 BC, of the City of Rome [V. R.] 667. But the war of Pompey and Caesar began in the year of the world 3901, 47 BC. When Mithridates was preparing war against the allies, portents appeared, etc. Into the same place (where the Senate is usually held) a huge star [ſydus] was sent down from the sky. Lycosthenes reports this under the year of the world 3877 and 86 BC.

60 BC. [Ante natum Chriſtum 60.]

In the year of the world 3903, 60 BC, a comet appeared for a space of nine days. After it, Catiline [Catelina] is not only defeated in war by Antonius [Antonio] but also killed. Rockenbach [Rockenb.]. According to Calvisius [Calviſ.], in the year of the world 3888, 60 BC, in the year 691 from the founding of the City [ab Vrb. conditâ], Catiline was slain, with Petreius in command [Duce Petrejo], when Junius Silanus and Licinius Murena were consuls [Iunio Silano & Licinio Murenâ Coſs.]. Around the year 60 BC another comet was observed by Posidonius, as Seneca indicates in book 7, chapter 20 [l. 7,c. 20], says Riccioli.

[Margin: Deficiente Sole Cometa illuxit.] *A comet shone out when the Sun was eclipsed.* We do not see many comets, because they are obscured by the rays of the Sun. Posidonius reports that when the Sun was eclipsed [quo deficiente] a certain comet appeared, which the neighbouring Sun had hidden. Seneca, *Natural Questions* book 7, chapter 20 [Seneca l. 7,N. Q. c. 20.].

47 or 46 BC. [Ante natum Chriſtum 47 vel 46.]

In the year of the world 3901, 47 BC [ante N. Ch. 47], the war of Pompey and Caesar began; and in the following year Pompey was defeated and killed. Pliny the Elder hints that a comet was seen at the time of this war. Before the civil war of Pompey and Caesar several comets blazed, as Pliny the Elder and Lucan [Lucano] testify. Eberus.

41 BC. [Ante natum Chriſtum 41.]

In the year of the world 3922, the year of the City of Rome 710, 41 BC, a comet of dreadful size (in the sign of Scorpio [inSigno Scorpii], as some would have it), together with other wonders in the sky, blazed for seven nights after the death of Julius Caesar [JuliiCæſaris], and rose before sunset. Rockenbach. This is the comet of which Augustus wrote a full account [perſcripſit]. Myzaldus [Myzald.] assigns a comet to this time, book 1, chapter 9 [lib. 1, c.9.]. [Margin: Xiphias, enſis faſtigiato mucrone.] *Xiphias: a sword with a tapering point.* There are also the Xiphiae, he says, which show the shape of a sword with a tapering point (from which the Greeks gave them their name), and which are pale with the sheen of a blade, without any rays. Such a comet, they say, blazed out when Marcus Antonius and Publ. Dolabella were consuls [Marco Antonio & Publ. Dolabella Conſulibus], when the civil war between Octavius and Marcus Antonius himself [ipſum M. Antonium] began to flare up. According to Calvisius [Calviſ.], C. Julius Caesar [C. Iulius Cæſar] and Marcus Antonius were consuls in the year of the world 3906, 42 BC, 709 from the City [ab Urb. 709]. Julius Caesar, however, appointed Dolabella in his own place shortly before his death; and in that very year Octavius Augustus began to make war against Antonius.

39 BC. [Ante Chriſtum 39.]

[Margin: Cometa tempore Julii Cæſaris.] *A comet in the time of Julius Caesar.* In the 3rd year after the murder of Julius Caesar [Iulii Cæſaris], around the second succession [ſecundam ſucceſſionem] of Augustus and Antonius, which according to Calvisius falls in the year 39 BC [ante Chriſt. 39], Marianus Scotus reports that a haired star appeared, book 1, Age [Ætat.] V, chapter 21, page 353.

When M. Antonius and P. Dolabella were consuls [M. Antonio & P. Dolabella Conſul.]. When Augustus entered Rome at the third hour of the day, surrounded by a huge crowd, the Sun, enclosed in a small orb of pure and clear sky, encircled him with the ring of its outermost line [extremæ lineæ circulo], such as a bow is usually stretched in the clouds. At the games of Venus Genetrix, which he held on behalf of the College, a haired star rose at the eleventh hour under the star of the Septentriones [ſub ſeptentrionum ſydere] and turned the eyes of all, etc. Julius Obsequens [Iulius obſequens]. According to Calvisius, Augustus entered Rome in 42 BC, around April 11 [circa undecimum Aprilis].

28 or 29 BC. [Ante Chriſtum 28 vel 29.]

In the year of the world 3935, 29 BC, a comet appeared in Libra, blazing for 95 days. In the same year Octavius Caesar [Octavius Cæſar], having defeated Antonius, subjugated the whole of Egypt. Rockenbach. According to Calvisius, Antonius, defeated by Augustus, took his own life in the year of the world 3920, 28 BC [ante natum C. 28], in the year of the City 723 [an. Urb. 723]. In 28 BC [A. ante C. 28.] stars were also seen, which the Greeks call comets. Lycosthenes.

27 BC. [Ante natum Chriſtum 27.]

In the very days of my games a hairy star [ſydus crinitum] was seen for seven days in the region of the sky that lies beneath the Septentriones. [Margin: Clarum & omnibus conſpicuum Sidus.] *A bright star, visible to all.* It rose around the eleventh hour of the day, and was bright and visible in all lands. Augustus is said to have written it, in Pliny the Elder, book 7, chapter 25 [Plin. lib. 7, c. 25.].

The one that emerged after the murder of the Divine Julius [Divi Iulii], at the games of Venus Genetrix [Veneris Genitricis], around the eleventh hour of the day. Seneca, *Natural Questions* book 7, chapter 17 [Senec. l. 7, N. Q. c. 17.].

23 BC. [Ante natum Chriſtum 23.]

In the year of the world [Anno Mundi] 3940, 23 BC: a comet appeared for some days in the sign of Taurus. Rockenbach.

History of the Comets after the Birth of Christ [Hiſtoria Cometarum poſt natum Chriſtum.]

AD 1 [A. C. 1.]: a comet, or as some would have it a burning torch [fax ardens], was seen in the sign of Leo for three nights together with a lunar eclipse; Herod's slaughter of the infants [infanticidium Herodis] followed. Rockenbach.

AD 10. [Post Chriſtum 10.]

[Margin: Cometa per menſem apparuit.] *A comet appeared for a month.* AD 12 [A. C. 12.]: a comet appeared for 32 nights in the sign of Aries; Quintilius Varus was cut down by Arminius [ab Arminio]. Rockenbach.

> As when, the treaty broken, savage Germany carried off the commander Varus, and stained the fields with the blood of three legions, and lights blazed far and wide, threatening the whole world.

Lavatherus [Lavather.], from Lucan.

According to Calvisius, the defeat of Varus took place in the year of Christ [anno Chr.] 10. AD 13 [A. C. 13.]: Quintilius Varus [Quintil. Varus] was cut down by the Germans; various portents foretold this defeat, among which there was also a comet. Lycosthenes [Lycoſth.], from Lucan.

AD 14. [Anno Chriſti 14.]

AD 17 [A. C. 17.]: a comet appeared in the sign of Aries for a space of 20 days. After it, in the following year, came the death of Caesar Augustus. Rockenbach [Rock.].

Augustus dies, according to Calvisius, in AD 14 [an. C. 14.]. Suetonius records that blood-red comets, among other portents, went before his death. When Sext. Pompeius Nep. and Sext. Appuleius Nep. were consuls [Sext. Pompejo Nep. & Sext. Appulejo Nep. Coſs.].

About AD 38. [Anno Chriſti 38 circiter.]

AD 40 [A. C. 40.]: after the death of Tiberius Caesar, under the rule of Gaius Caligula [imperante Cajo Caligulâ], a comet appeared in the sign of Gemini. Rockenbach. The exile of Herod followed. According to Calvisius [Calvif.], Tiberius dies in AD 37 [A. C. 37.]; Herod Antipas is sent into exile in the year 40.

AD 54. [Anno Chriſti 54.]

[Margin: Cometa per quatuor integros menſes fulſit.] *A comet shone for four whole months.* AD 56 [Anno C. 56]: a comet appeared in the sign of Cancer, and, as some would have it, blazing for a space of four months and directing its course from the north towards the east, and shining dimly [obſcurèq; lucens]. The death of Claudius Caesar followed. Rockenbach. According to Calvisius, Claudius was killed by poison in AD 54 [an. C. 54.]. For Robkenbach [recte: Rockenbach] does indeed have a comet under AD 48 [ad an. C. 48], but one that he says also went before the death of Claudius, so that it will certainly be the same as this one. Lycosthenes reports the death of Claudius and the comet under the year AD 48 [ad annum C.48], but a little later also under AD 56 [ad an.C.56.].

AD 60. [Anno Chriſti 60.]

[Margin: Spatio ſex menſium Cometa ſex quoque Signa trajecit.] *In a space of six months the comet also crossed six signs.* AD 62 [A. C. 62]: under the rule of Nero a comet was seen, blazing for a space of six months and directing its course from the east partly towards the west, partly towards the south. Rockenbach.

This one, which we saw in the most happy principate of Nero [Neronis Principatu lætiſſimo], offered itself to view for six months, turned round in the opposite direction to that Claudian one. For that one, rising from the north towards the zenith [in verticem], made for the east, growing ever fainter; this one began from the same quarter, but, heading for the west, bent towards the south, and there withdrew from sight [ſe ſubduxit oculis]. Seneca, *Natural Questions* book 7, chapter 21 [Sen. l. 7, Nat, Q. c.21.]. Next, this most recent one [hic proximus] began its motion from the north, came through the west into the southern parts [in Meridiana], and, lifting its course, hid [oblituit]. That other, Claudian one, first seen from the north, did not cease to rise ever

higher, straight up [in rectum], until it departed. Seneca, book 7, chapter 29 [Sen. l. 7, c.29.]. For this most recent one ran across half of the sky within the sixth month; the earlier one withdrew within fewer months. Seneca, in the same place [Senec. ibid.].

When Nero was consul for the 4th time [Conſule Nerone IV] with C. Cornel. Lentulus, a quinquennial contest [quinquennale ludicrum] was instituted at Rome, etc. Among these events a comet star [ſidus Cometes] also shone out, which the common people take as portending a change of king. Tacitus, *Annals* book 14 [Tacit. l. 14 Annal.]. According to Calvisius and Riccioli [Calviſ. & Ricciol.], Nero's 4th consulship [Neronis Conſulatus I V] falls in AD 60 [in annum C. 60.]. Lycosthenes [Lycoſth.], however, puts it under the year 62.

AD 64. [Anno Chriſti 64.]

[Margin: Cometa Neronis tempore.] *A comet in the time of Nero.* AD 66 [A.C. 66,], in the 10th year of Nero's reign, a comet appeared, of which Tacitus writes in *Annals* book 15 [Tacit. l. 15 Annal.]: At the end of the year portents are reported, heralds of impending evils. Lightning [Vis fulgurum] more frequent than at any other time, and a comet star [Sidus Cometes], always expiated by Nero with illustrious blood, etc. Then P. Silius Nerva and C. Julius Atticus Vestinus enter upon the consulship. Tacitus, *Annals* book 15, 47 [Tacit. l.15 Annal. 47.]. According to Calvisius, in AD 65 [A. C. 65,] the consuls are Nerva and Vestinus. Therefore the comet was seen in AD 64 [anno Ch. 64.]. When C. Levanius Bassus and M. Licinius Bassus were consuls [Conſulibus C. Levanio Baſſo & M. Licinio Baſſo]: as Eckstorm [Eckſtormius] notes.

AD 66 or 68. [Anno Chriſti 66 vel 68.]

[Margin: Tres Cometæ tempore Neronis.] *Three comets in the time of Nero.* AD 70 [A. C.70.]: a comet appeared in the sign of Gemini, just as two had also been seen earlier in the time of Nero; persecutions of the Christians followed, among which Peter and Paul were put to death [ſupplicio affecti]. Rockenbach [Rockenb.]. Myzaldus refers three comets seen in the times of Nero to the sign of Gemini, page 164 [pag 164]. While three comets were seen at Rome in the times of Nero, Peter and Paul preached the Gospel. Lavatherus [Lavath.], from Suessanus [ex Sueſſano]. D. Christiani [D. Chriſtiani] reports comets under AD 68 and 69 [ad A. C. 68 & 69]. According to Calvisius, Nero kills himself in AD 68 [A. C. 68].

The comet that appeared when Paterculus and Vopiscus were consuls [Paterculo & Vopiſco Conſulibus] brought about the things that were foretold by Aristotle and Theophrastus [ab Ariſtotele Theophraſtoq;]. Seneca, book 7, chapter 28 [Senec. l. 7, c. 28.]. I would believe, says Riccioli, that these were suffect or honorary consuls; for I do not find them in the list [Catalogo] of ordinary consuls.

AD 70. [Anno Chriſti 70.]

[Margin: Cometa enſiformis integro auro conſpicuus.] *A sword-shaped comet, conspicuous with pure gold.* In AD 71 [Anno Chriſti 71] (others assert that this happened in the following year), in the 1st year of Vespasian's reign [Veſpaſiano Imperii anno 1], a comet showing the figure of a sword appeared in the dodecatemory of Virgo [in dodecatemorio Virginis] in the sky, on the day of Unleavened Bread [Azymorum die], which was April 8, together with many other signs, for the space of a year, above the city of Jerusalem. Rockenbach. Lavatherus [Lavath.]. According to Calvisius [Calviſ.], Jerusalem was destroyed in AD 70 [anno Ch. 70].

In AD 71 [Anno Chriſti 71], the first year of the Emperor Vespasian, a comet Xiphias [Cometes Xiphias] was seen for a whole year. In the following year the wretched destruction of the City and of the Jewish nation followed it. Prætorius.

In AD 71 [A. C. 71,], under the rule of Vitellius [Vitellio Imperante], ill-omened portents appeared; for a comet appeared, and the Moon was seen to be eclipsed twice, against the reckoning of the appointed time. It was also darkened on the fourth and the seventh day, etc. Lycosthenes [Lycoſth.], perhaps from Xephilinus [ex Xephilino]. Calvisius has it that Xephilinus records two eclipses in this year, which he affirms were preternatural; but also that other authors are silent about these, and he affirms that he himself finds two natural eclipses in this year by calculation.

In AD 72 [Anno Chriſti 72,], Rockenbach again has a comet appearing in the sign of Libra for 40 continuous days.

AD 76. [Anno Chriſti 76.]

[Margin: Cometa Jaculi formam habens.] *A comet having the form of a javelin.* There was an Acontias (a kind of comet that takes its name from its likeness to a javelin), of which the Emperor Titus wrote a full account [perſcripſit] in a splendid poem in his fifth consulship. Lavatherus [Luvath] [recte: Lavath.], from Pliny the Elder, book 2 [ex Plin. lib. 2.]. According to Calvisius [Calviſ.], the fifth consulship of Titus falls in AD 76 [in annum Ch. 76.]. According to Funccius [Funccium], in Lavatherus and Rockenbach [apud Lavatherum & Rockenbach], in the year 77. Sext. Aurel. Victor also mentions it, in his Vespasian [in Veſpaſiano].

AD 79. [Anno Chriſti 79.]

In AD 81 [Anno Chriſti 81,], a comet appeared before the death of the Emperor Vespasian. Rockenbach [Rockenb.], Lycosthenes [Lycoſth.]. In the year 79 [Anno 79,], a comet appeared, shortly before Vespasian died. Calvisius [Calviſ.], from Suetonius [ex Sveton.]. Lavatherus [Lavath.] puts the same one under the year 78 [ad ann. 78].

[Margin: Cometa ſex Menſes duravit.] *A comet lasted six months.* In AD 78 [Anno Chriſti 78], in the third year before the death of the Emperor Vespasian

[Veſpaſiani Imp.], a comet appeared in the form of a javelin, or acontias, which burned for 180 days, that is, 6 months [6 Menſ.], from Pliny the Elder, book 2, chapter 25 [Plin. Lib. 2 cap. 25] and Comment. Melich. Eckstorm [Eckſtormius].

AD 128. [Anno Chriſti 128.]

In AD 130 [Anno Chriſti 130,], a comet in the sign of Aquarius and Capricorn for 39 ni- ghts was seen. An earthquake followed, by which Nicopolis and Caesaria [Cæſaria] were swallowed up. Rockenbach. Calvisius has it that Nicopolis and Caesarea [Cæſaream] collapsed in AD 128 [anno Chriſti 128].

AD 145. [Anno Chriſti 145.]

[Margin: C.meta in Aquario 6 menſium ſpatio viſus.] [recte: Cometa] *A comet seen in Aquarius for a space of 6 months.* In AD 145 [Anno Chriſti 145], in the time of Antoninus Pius [Antonini Pii], a comet appeared in Aquarius, blazing for 6 nights. An earthquake and a flood followed. Rhodes [Rhodus] and other famous places were dreadfully shaken, etc. Rochenbach [recte: Rockenbach].

About 188. [Circa 188.]

At that time (under the rule of Commodus [ſub Imperio Commodi], who took up the imperial power around AD 181 [circa annum Chr. 181]) certain portents also appeared in the sky. For stars appeared in the sky continually, and some of them, drawn out lengthwise (the Pogonias is a kind of comet that takes its name from its likeness to a beard), seemed to hang as it were in mid-air; the Temple of Peace suddenly burned down. Lavatherus, from Herodian, book 1 [ex Herodian. lib. 1.]. Rockenbach refers this one to AD 188 [ad annum C. 188]. Calvisius has it that in that year the Capitol was struck by lightning, and that the most sumptuous Library burned down together with the neighbouring buildings.

In the year 195 [Anno 195], in the time of Severus, a comet was seen, of which the opinion was that it portended some great evil. Lavatherus, Alstedius [Alſtedius]. It is the same as the following one, of the year 205; for Severus began to reign in the year 195, and in the 10th year of his reign Plautianus was killed, and this comet is said to have preceded his death.

AD 204 or 205. [Anno Chriſti 204 vel 205.]

Before this happened (he is speaking of the death of Plautianus), a very large whale put in to the harbour of Augustus [Auguſti portum] and was caught in it. Moreover a comet was seen at Rome for many days. Lavatherus [Lavather.] and Xephilinus, in his Severus [in Severo]. According to Calvisius, Plautianus is killed in AD 205 [anno Chr. 205].

A comet was seen at Rome for many days, and the opinion was that it portended some great evil. Plautianus was killed for his notorious licence and cruelty. Lycosthenes [Lycoſth.].

In AD 204 [Anno Chriſti 204], in the tenth year of Severus's reign [Decimo Imperii Severi], a comet appeared at Rome for many days. Rockenbach.

AD 217 or 218. [Anno Chriſti 217 vel 218.]

[Margin: Cometa in Piſcibus ab ortu in occaſum latus eſt.] *A comet in Pisces was carried from the rising to the setting.* In AD 220 [Anno Chriſti 220], a comet appeared for 18 days in the sign of Pisces, and it had its motion from west to east. Shortly afterwards the death of Caracalla followed it. Rockenbach [Rockenb.]. In the year 218 [Anno 218], a comet appeared, advancing from west to east. Calvisius [Calviſ.], from Dio [ex Dion.]. But Caracalla was killed in the year 217, on April 8 [April. 8.]. Under the rule of Macrinus [Imperante Macrino] a star was seen for many nights, from the west towards the rising Sun [in orientem Solem]. Lycosthenes [Lycoſthen.], Eckstorm [Eckſtorm.], from Xiphilinus [ex Xiphilino].

AD 306 or 305. [Anno Chriſti 306 vel 305.]

In AD 308 [Anno Chriſti 308], before the death of Constantius Chlorus [Conſtantii Chlori], who died in Britain in the following year, a comet appeared. Rockenbach [Rockenb.]. This Constantius died in the year 306, on July 25 [Iul. 25.].

About AD 323. [Anno Chriſti 323, circiter.]

In AD 324 [Anno Chriſti 324,] (or 23) a comet appeared in Virgo. This one [Hunc] was followed by a dreadful war [horrendum] between Constantine the Great [Conſtantinum M.] and Licinius; and the doctrine of Arius [dogma Arrii] was condemned. Rockenbach, Eckstorm, Herlicius. According to Calvisius, Constantine's war against Licinius had already begun in the year 314 [anno 314]. Arius [Arrius] was condemned at Nicaea [Nicææ] in AD 325 [anno Chr. 325]. Around the year 323 [Circa annum 323], Arius the presbyter [Arrius Presbiter], expelled from the Church, stirred up a pestilent heresy, etc. Peucerus writes in the book *de Divinat.* [lib. de Divinat.], p. 359, that comets preceded it [Hanc]. Lavatherus.

AD 337. [Anno Chriſti 337.]

[Margin: Stella crinita immenſæ magnitudinis apparuit.] *A haired star of immense size appeared.* In AD 340 [Anno Chriſti 340] (or 41) a comet of immense and terrible size was seen in the sign of Aries for 6 months and three days. Rockenbach [Rockenb.], from Orosius [ex Oroſ.], book 7, chapter 19 [lib. 7 c. 19.]. Eutropius [Eutrop.], book 10 [l. 10.]. Wolfius, *Centur.* 4. *Fascic. Tempor.* [Faſcic.Tempor.], folio 476. Eckstorm [Eckſt.].

His death (that of Constantine the Great [Conſtantini M.]) was also announced by a haired star [crinitam Stellam], which shone for some time with an unusual size. Eutropius [Eutrop.], book 10 [l. 10.]. According to Calvisius, Constantine the Great [Conſtant. M.] dies at Nicomedia [in Nicomediâ] in

AD 337 [anno Chr. 337]. Orosius indeed relates the death of Constantine, but no comet.

About AD 363. [Anno Chriſti 363 circiter.]

[Margin: Cometa interdiu viſus.] *A comet seen by day.* In AD 363 [Anno Chriſti 363], when Jovian [Iovianus] returned from Persia to Antioch [Antiochiam], many miracles and prodigies were seen for days on end; and the stars of comets [ſidera Cometarum] were seen by day. Eckstorm, from Ammianus [ex Ammiano], book 25 [lib. 25.].

In AD 367 [Anno Chriſti 367], while the Emperor Julian [Imperatore Juliano] was waging war against the Persians and was at last killed in it, a comet was seen on a clear day, together with other terrible miracles. Rockenbach. Calvisius [Calviſ.]: Julian fell in battle in AD 363 [anno Chriſti 363]; D. Christiani [D. Chriſtiani] assigns his comet to that year as well as to 367.

AD 365. [Anno Chriſti 365.]

[Margin: Cometa in Ariete per 11 Septim. fulſit.] *A comet shone in Aries for 11 weeks.* In AD 370 [Anno Chriſti 370], a comet shone in Aries for eleven weeks; an earthquake throughout almost the whole world followed it. Rockenbach. Calvisius refers that huge earthquake to the year 365. In the year 377 [Anno 377], after a comet had appeared [Cometa facto], an earthquake occurred throughout almost the whole world, etc. In the same year Valentinian Augustus [Valentinianus Auguſtus] crushed the Saxons in the land of the Franks [in terrâ Francorum]. According to Calvisius, the earthquake is assigned to the year 365, the defeat inflicted on the Germans [germanis] by Valentinian likewise to the year 365, and another, again, to the year 366. In the year 375, however, Valentinian dies. Eckstorm [Eckſtorm.], from Ammianus, book 30 [Lib. 30.], notes that in that year haired stars of comets [crinita Sidera Cometarum] shone.

About AD 380. [Anno Chriſti 380 circiter.]

[Margin: Lucidisſimus Cometa major Venere.] *A very bright comet, larger than Venus.* About AD 380 [Circ. A. C. 380], a star wonderful to see, of round shape and larger than the planet Venus, and which lit up the whole horizon, was seen burning in the sign of Libra for 4 months, namely from the beginning of May until September. Rockenbach.

AD 384. [Anno Chriſti 384.]

[Margin: Cometa Columnæ ardenti ſimilis.] *A comet like a burning column.* About AD 384 [Circa A. C. 384.], while Theodosius and Gratian [Theodoſio & Gratiano] were reigning, a comet like a column [Columnæ] in every respect was seen for some time. Rockenbach [Rockenb.]. Lycosthenes; see the year 394 [vide Ann. 394.]. Under the Emperor Theodosius, they write, a comet shone that was similar to the one of Jerusalem [illi Hieroſolymitano]. The beginning of his reign in the East is referred to the year 383 [ann. 383], a reign that lasted 17 years. In the twelfth year of the same emperor (AD 394 [A. C.

394]) a sign appeared in the sky like a dove [Columba], hanging and burning, for 30 days. Whether [An] one may count this too among the comets, I leave to each person to decide. Prætorius.

According to Calvisius, Theodosius was taken by Gratian into partnership in the empire in AD 379 [ann. C. 379], on January 16 [die Januarii 16]; he reigned 16 years and two days.

AD 390. [Anno Chriſti 390.]

[Margin: Claritate vix ceſſit Veneri.] *In brightness it scarcely yielded to Venus.* In AD 389 [A. C. 389] a comet rising from the north, and burning like the Morning Star [inq; modum Luciferi ardens], appeared blazing in the sign of Gemini for 20 days. Hail follows, crackling for two days on end. Rockenbach [Rockenb.]. Alstedius. In about the year 390 [An. ferè 390] that comet appeared which Proclus saw above Jupiter (as Peucerus has it, in Tycho [apud Tychon.], volume 1 [Tom. 1], pp. 619 and 625). Riccioli [Ricciol.].

In the year 389 [An. 389] a star rising from the north at cockcrow, and burning like the Morning Star, before it appeared shining [priusquam ſplendens apparuit], ceased to exist on the twentieth day. Cuspinianus, in his *Consuls* [in ſuis Conſulibus], from Marcellinus [ex Marcellino]. Lavatherus [Lavath.]. In the year 390 [An. 390] a sign appeared in the sky like a column, hanging and burning, for thirty days. Calvisius, from Marcellinus [ex Marcell.]. I think it is plainly the same one that Prætorius refers to the year 394 [ad ann. 394.].

AD 392. [Anno Chriſti 392.]

[Margin: Cometa in formâ gladii ancipitis & horrendi.] *A comet in the form of a two-edged and dreadful sword.* In AD 393 [An.C. 393] a comet showing the form of a sword [Enſis formam referens], etc., was seen. Rockenbach. Then indeed (in the reign of Theodosius [Imperante Theodoſio], who began to reign in the year 383 [an. 383]) unusual prodigies too were seen, etc. For first an unexpected and unusual star appeared in the sky in the dead of night, shining near the Morning Star [propè Luciferum], around the zodiacal circle [circa Zodiacum Circulum]. Because its flashing rays made it huge and bright, it was not much inferior to the Morning Star. Little by little, moreover, a huge mass of other stars also gathered to it. Had you seen that spectacle, you would have compared it to a swarm of bees flying round their leader in a circle. And the light that flashed out from all of them, as if from a mutual and violent collision, mingled into one single flame, and, shining with a kind of terror, it presented the very likeness of a great and dreadful two-edged sword. For the other stars fell back into one and the same appearance, and the one star alone that had been seen first appeared, in its whole bearing, like a root or a kind of hilt, and in some way put forth the whole brightness of that displayed star; and just like a burning wick from a lamp, the flame was raised on high. This sight thus offered a new kind of spectacle.

Its motion, however, differed entirely from the course of all the stars. For at first, beginning to move from the place we mentioned, it both rose and set together with the Morning Star. Then, gradually drawing away from it, it held its course slowly and step by step, turned as it were towards the Bears [ad Urſas], and as it were to those watching [veluti aſpectantes] it advanced obliquely to the left on its own path. It completed the same circuit in common with the other stars it had approached. By its own motion, however, which was drawn out to the fortieth day, it at last barely reached Ursa Major [Urſam majorem], and vanished in the middle part of that constellation [aſtri ejus], where it had last shone. At the very time when this star appeared, sword-bearing [Enſifera], or rather showing the form of a sword, two monstrous men appeared at the same time, etc. Soon afterwards Valentinian the Younger [Valentinianus Junior] was slain through the agency of a certain Arbogastes [Arbogaſtis cujusdam]. Eugenius seized the Western Empire [occidentale imperium]. Lavatherus [Lavath.] and Eckstorm [Eckſtorm.], from Nicephorus [ex Niceph.], book 12, chapters 37 and 38 [lib. 12, c. 37 & 38.].

Valentinian was killed in the year 392 [An. 392.], and in the same year, according to Calvisius [juxta Calviſium], Eugenius seizes the Empire.

[Margin: Stella inſtar Columnæ deprehenſa eſt.] *A star was observed in the likeness of a column.* In AD 394 [A. C. 394] a star like a column [quaſi Columna], or, as some would have it, a dove [Columba], burning and hanging in the sky (on the testimony of Prosper [teſte Proſpero]), not unlike the morning star [lucifero], appeared towards the north, near the Morning Star [Luciferum] in the Zodiac, and blazed for 30 days. Rockenbach [Rock.].

In the twelfth year of the Emperor Theodosius a sign appeared in the sky like a dove [Columba], hanging and burning, for 30 days. Prætorius (see above, the year 384 [vid. ſupra ann. 384]), Wolfius, Lycosthenes.

In the year 393 [Anno 393.] a terrible sign appeared in the sky, like a column in every respect. Segebert Lycosthenes has a column [Columnam] under the year 384, but a dove [Columbam] under the year 394.

AD 396. [Anno Chriſti 396.]

In AD 396 [A. C. 396] a comet appeared, when Theodosius fought against Eugenius and defeated him. Rockenbach [Rockenb.]. Calvisius places the war of Theodosius and his victory over Eugenius in AD 394 [A. C. 394.].

AD 400. [Anno Chriſti 400.]

[Margin: Cometa ſplendidus ac enſis ſpeciem referens.] *A splendid comet, showing the appearance of a sword.* Around AD 403 [Circa annum C. 403] Gainas, an Arian general [Dux Arrianus], had it in mind to lay waste the city of Constantinople [Urbem Conſtantinopolin], etc. These plots were foretold by that star showing the appearance of a sword, which was exceedingly bright (such as had never been reported in written record to have appeared before), shining over the city itself and reaching from almost the top of the sky down

to the earth itself. Lavatherus [Lavath.], from Nicephorus [ex Niceph.], book 13, chapter 6 [l. 13, c. 6.]. Sozomen [Sozomen.], *Ecclesiastical History* [Hiſt. Eccleſ.], book 8, chapter 4 [l. 8, c. 4.]. Socrates [Socrat.], book 6, chapter 5 [lib.6 c. 5.]. According to Calvisius [Calviſ.], Gaina tries to seize Constantinople in AD 400 [A. C. 400]. Lycosthenes refers these events to the year 412.

AD 402. [Anno Chriſti 402.]

In the year 405, however [Anno verò 405], in which Stilicho [Stilico] defeated the Getae [Getas], a comet appeared that Claudian [à Claudiano] described in his poem *On the Getic War* [in Poëmate de Bello Getico]. Riccioli [Ricciol.]. According to Calvisius [Calviſ.], Stilicho [Stillicho] defeated the Goths in the year 402.

AD 409. [Anno Chriſti 409.]

In AD 413 [A. C. 413], a comet appeared blazing in the sign of Virgo for 4 months, before Alaric [Alaricus] stormed Rome. Rockenbach. See what is noted at the next comet.

[Margin: DeficienteSole, Cometa Coni ſpeciem gerens conſpectus eſt.] *When the Sun was eclipsed, a comet bearing the appearance of a cone was seen.* That disaster, moreover (inflicted on the Romans by Alaric [ab Alarycho]), was obscurely foretold by that star showing the form of a sword, etc. Then indeed there was also so great an eclipse of the Sun that the stars shone out even at midday, etc. When the Sun was eclipsed, a certain brightness appeared in the sky at the same time, bearing the appearance of a cone or a turning-post [Coni ſive Metæ], which certain unlearned people took to be a comet and a haired star. For nothing of what was seen in it was like a comet. That brightness neither spread into a coma [in comam], nor showed at all the appearance of a star; instead, like the flame of some great lamp, it seemed to subsist by itself, and none of its rays took on the form of any star. It also varied in its very motion. For that brightness began to move in the part where the Sun rises at the equinox, and from there, gradually making its way past the last star, the one that lies in the tail of the Bear [in Urſæ caudâ], it held its course to the west. But after it had measured out the sky, by its own motion over more than four months, it vanished completely. At times, indeed, its top stretched out to a great and sharp length, so that it exceeded the proportions of a cone; at other times, however, it was drawn in to the cone's measure. It also presented other monstrous spectacles, in which it departed from the nature of the usual apparitions. It began to be seen, moreover, from about midsummer until the end of autumn. Nicephorus, book 13, chapter 36 [lib. 13 cap. 36.].

AD 418. [Anno Chriſti 418.]

In AD 418 [A. C. 418] a comet was seen up to the month of September. Lavatherus [Lavath.], from Herm. Contract. [ex Herm.Contract.]. Two years later Jerome [Hieronymus] died.

[Margin: Eclipſis Solis tempore Honorii.] *An eclipse of the Sun in the time of Honorius.* In AD 418 [A. C. 418], the 10th of Honorius [Honorii 10], an eclipse of the Sun took place on the 14th day before the Kalends of August [14 Calend. Auguſt.], and a comet was seen up to the month of September. Herm. Contract. Calvisius has that eclipse under the same year. Lycosthenes [Lycoſth.]. Herlicius asserts that this comet was seen in Libra; but from which authors, I do not know.

AD 423. [Anno Chriſti 423.]

In the year 423 [A. 423] the Emperor Honorius dies on August 15 [die 15 Auguſti]. A comet preceded his death, as Marcellinus has it. Calvisius [Calviſ.]. In the same year Eckstorm [Eckſtormius] also reports, from Schosserus [ex Schosſero], that a horrible comet blazed.

AD 442. [Anno Chriſti 442.]

In AD 434 [A. C. 434] a comet appeared, and soon, a few days later, blood flowed at Toulouse [apud Toloſam]. Lavatherus [Lavath.], from the *Fascicul. Temporum* [ex Faſcicul. Temporum]. Lycosthenes [Lycoſt.]. Rockenbach [Rockenb.].

D. Christiani [D. Chriſt.] and Alstedius report a comet under the year 443 in almost the same words [iisdem penè verbis]; nor does the *Fasciculus temporum* [Faſciculus temporum] give a more precise time than that the comet was seen between the years 434 and 444 [intra annum 434 & 444].

[Margin: Deficiente Lunâ Cometa apparet.] *When the Moon is eclipsed, a comet appears.* The Moon is darkened, a comet appears, and after a few days a very long stream of blood flowed for a whole day at Toulouse in Gaul [apud Toloſam Galliæ]; *Fasc. Tempor.* [Faſc. Tempor.], between the years 434 and 444 [intra annum 434 & 444].

In the year 442 [A. 442] a comet burns for very many days. Calvisius, from Marcellinus [exMarcellino]. Likewise Eckstorm [Eckſtormius], from Schosserus [ex Schosſero].

AD 448. [Anno Chriſti 448.]

In AD 448 [A. C. 448], while a comet was shining continuously for many days, there was an earthquake in the east [in oriente]. Rockenbach [Rockenb.]. Lavatherus [Lavath.], from Suesson. [ex Sueſon.]. Lycosthenes [Lycoſth.]. Myzaldus, Eckstorm [Eckſtormius] and Herlicius, who refers [refert] the same one to the sign of Leo, p. 167 [pag. 167.]. Attila afflicted a great part of Italy with war; Venice is founded in the sea [Venetiæ in mari conduntur].

About AD 454. [Anno Chriſti. 454. circiter.]

In AD 454 [A. C. 454], in the 26th year of the Emperor Valentinian [Anno 26 Valentiniani Imperatoris], a comet [Cometes] shone in the west, the sky burned, and burning spears, as also other prodigies, were seen in the sky.

Concerning these: Trithemius, Prætorius, Funccius, Rockenbach. Lycosthenes [Lycoſthen.]. Eckstorm [Eckſtorm.]. Schosserus.

In the year 454 [An. 454] continual earthquakes, comets and various signs appeared in the sky. Palmerius [Palmer.]. Lavatherus wrongly refers this to the year 453. According to Sigebertus [Sigebertum], however, these things happened in the year 452.

[Margin: Mirum Cometæ jubar.] *A wondrous radiance of a comet.* In the year 457 [Anno 457] a star of wondrous size appeared over the Island of Britain [ſuper Inſulam Britanniæ]; to its ray clung a fiery sword, like a dragon [Draconi ſimilis]. From its mouth two rays went forth, one of which stretched beyond Gaul, while the other again heading toward Ireland [Hyberniam], ended in seven smaller rays. Eckstorm [Eckſtormius], from Sigebertus [ex Sigeberto].

About AD 459. [Circa annum Chriſti 459.]

[Margin: Cometa fuſcâ nube cinctus.] *A comet girt with a dark cloud.* In AD 459 [A. C. 459] Chilperic [Chilpericus], King of the Franks, began to reign; in his time a comet was seen surrounded by a dark cloud, shining with its own ray. Lavatherus [Lavath.], from Robert. Ganguin., book 2 [lib. 2.]. According to Calvisius [Juxta Calviſium] (with whom Robertus Ganguinus does not disagree either), on the death of Chlothar [Clotario], Chilperic comes to the throne in AD 565 [anno Ch. 565], and reigned 24 years. Ganguinus has a comet toward the end of his reign. Hence it will perhaps be the same as the one that is referred to the year 587. According to Ganguinus, Chlothar Chilperic [Clotarius Chilpericus] was likewise still living in the year 536; see fol. 57, 6 [vid. fol. 57, 6.].

About AD 488. [Circa annum Chriſti 488.]

About AD 488 [Circa A. C. 488], various signs in the sky and unusual comets appeared. Lavatherus [Lavath.], from Sebast. Franck. [ex Sebaſt. Franck.]. Lycosthenes.

AD 504. [Anno Chriſti 504.]

[Margin: Stupenda Cometæ Cauda.] *An astounding tail of a comet.* In AD 504 [An. C. 504], about the time when Ambrosius Aurelius, King of Britain, departed this life, they report that a haired star [crinitam Stellam] (the Greeks call it a comet) was seen for several nights, giving off very long torches, and the likeness of a dragon, crowned and burning in the sky [ac Draconis effigiem coronatam & in cœlo ardentem]. H. Boethius, book 9, fol. 153 [lib.9, fol.153.].

AD 519. [Anno Chriſti 519.]

In AD 519 [An. C. 519] a comet was seen, of the form which they name Pogonias [Pogoniam] from its likeness to a beard; it was in the east, and sent its rays towards the west. Calvisius [Calvif.], from Cedrenus [ex Cedreno]. Michaël Glycæus writes that under the Emperor Justinian [ſub Juſtiniano Imperatore], about AD 520 [circa annum C. 520], a singular star was seen for 26 whole days.

Tadeáš Hájek [Thaddæus Hagecius], *Dialexis* on the New Star, p. 55 [p. 55 Dialex. de nova Stella.].

AD 539 or 535. [Anno Chriſti 539 vel 535.]

[Margin: Cometa in Sagittario.] *A comet in Sagittarius.* In AD 539 [A. C. 539], in the 13th year of the Emperor Justinian [anno Imper. Juſtinian. 13], in the month of December, a comet [Cometes] was seen in Sagittarius. Lavatherus [Lavath.], from Camerar. [ex Camerar.]. According to Calvisius too, the year of Justinian's reign falls in AD 539 [annum C. 539]; but the same Calvisius seems to assign this comet to AD 535 [A. C. 535]: For meanwhile, he writes, this winter, while the Sun was in Capricorn, a huge comet appeared in Sagittarius, etc. Procop. Between the years 534 and 544 [Intra annum 534 & 544], a certain star, coming against the Moon, entered. *Fascic. Tempor.* [Faſcic. Tempor.].

AD 541. [Anno Chriſti 541.]

In AD 541 [A. C. 541], at the feast of Easter [in feſto Paſchatos], a comet appeared in various parts of the Gauls [in diverſis Galliarum partibus], together with other terrible signs of the sky, which was seen to burn, and real blood rained onto people's clothing. A universal earthquake followed, which damaged Epidamnus [Epidamnum], Corinth [Corinthum] and Anazerbus [Anazerbum] above all the rest. Rockenbach [Rockenb.]. Sigebertus, Lycosthenes [Lycoſth.].

In the year 541 [An. 541], on the very day of the Lord's Resurrection, a remarkable comet [Cometes] was seen, which various signs in the air preceded in various places of the Gauls. Myzaldus [Myzald.], in the *Catalog.* [in Catalog.].

AD 555 or 556. [Anno Chriſti 555 vel 556.]

[Margin: Cometa in formâ lanceæ.] *A comet in the form of a lance.* In AD 556 [A. C. 556] a comet appeared in the form of a lance. Funccius [Funcc.], from the *Annal. Constantinop.* [ex Annal. Conſtantinop.]. Lavatherus [Lavath.] has the year 557. In AD 555 [An. Dn. 555] there appeared a fire in the sky, like the appearance of a lance. Albert. Abb. Stadens. [Albert. Abb. Stadenſ.]. In the year 555 [Anno 555] something like the appearance of a lance [quaſi ſpecies lanceæ] appeared in the sky, from the north into the west. Sigebertus [Sigebert.]. Lycosthenes [Lycoſth.]. A haired star in the form of a lance appeared at Constantinople [Conſtantinopoli]: Prætorius, Eckstorm [Eckſtorm.], from the *Annales Constantinop.* [ex Annalibus Conſtantinop.].

About AD 570. [Anno Chriſti 570 circiter.]

In the year 570 [Anno 570] a comet was seen, and the Lombards [Longobardi], with the eunuch Narses as their leader [Narſete Eunucho Duce], occupied Italy; but Alboin [Alboinus] is killed in the year 571. Riccioli [Ricciol.]. According to Calvisius, however, Alboin, King of the Lombards [Longobardorum Rex Alboinus], came into Italy in AD 568 [A.C.568], and was killed only in the seventh year after, as Turonensis affirms.

AD 586 or 587. [Anno Chriſti 586 vel 587.]

[Margin: Cometa fuſcâ nube circumdatus.] *A comet surrounded by a dark cloud.* In AD 589 [A. C. 589], when a comet had appeared for a month, many princes die, and in the fourth year from that one Mahomethus etc. [Mahomethus &c.] is born. Lycosthenes [Lycoſth.]. Lavatherus [Lavath.], from Suessanus [ex Sueſſan.]. Rockenbach [Rockenb.]. And in the year 587 [anno 587], which was the 4th of the Emperor Maurice [qui fuit IV Imperatoris Mauritii], a comet [Cometes] appeared at Byzantium [Bizantii], on the testimony of Zonaras [teſte Zonara]. Riccioli [Ricciol.]. According to Calvisius, the 4th year of Maurice [annus IV Mauritii] falls in AD 586 [A. C. 586]. During these days a comet was seen, surrounded by a dark cloud, shining with a single ray. Rob. Ganguin., book 2, fol. 25, 6 [lib. 2, fol. 25, 6.]. About the year 586 [Circa annum 586] a comet appeared among other prodigies. *Fascic. Tempor.* [Faſcic. Tempor.].

AD 594. [Anno Chriſti 594.]

In AD 594 [A. C. 594], under the rule of Agilulf, King of the Lombards [ſub Imperio Agilulphi Regis Longobardorum], a comet appeared in the month of January, which was seen for a whole month, in the morning and in the evening. At this same time Iohann., Archbishop of Ravenna [Archiepiſcopus Ravennæ], and Evin, Duke of Trento [Dux Tridentinus], died. Rockenbach [Rockenb.]. Lycosthenes [Lycoſthen.]. Diaconus, book 4, chapter 4 [lib. 4, cap. 4.]. Eckstorm [Eckſtorm.] and Prætorius.

In AD 594 [A. C. 594] a comet [Cometes] was seen in the sky for a month, at which time both a very great drought and a multitude of locusts afflicted Italy. Lavatherus [Lavath.], from Palmerius [ex Palmer.]. Bonfin., *Rer. Ungar.*, decade 1, book 8, p. 119 [Bonfin. Rer. Ungar. decad. 1, lib. 8, pag. 119.].

AD 597. [Anno Chriſti 597.]

In AD 597 [A. C. 597] a comet terrible in aspect was seen at Byzantium [Bizantii], while many other prodigies in the sky coincided with it at this time, which, because Mahometus was born in this year, etc. [quæ quia Mahometus hoc anno natus eſt &c.]. Rockenbach, Lycosthenes.

AD 599. [Anno Chriſti 599.]

In AD 599 [A. C. 599] Calvisius has, in Aimoinus [in Aimoino], that a comet appeared.

AD 601 or 602. [Anno Chriſti 601 vel 602.]

[Margin: Cometa immenſæ magnitudinis.] *A comet of immense size.* In AD 601 [A. C. 601] a comet of immense size was seen flashing for many days; soon after it followed the death of Maurice [mors Mauritii], together with many other prodigies. Rockenbach [Rockenb.]. Lycosthenes [Lycoſthen.]. Lavatherus [Lavath.], but in the year 603 [ſed anno 603]. Wolf., century 7 [Wolf. centur. 7.].

Again (after Maurice had been killed [poſt occiſum Mauritium]), in the months of November and September [Menſ. Novembri & Septembri] a comet appeared. Paul. Diacon., *Hist. Roman.*, book 8, on Phocas [Paul. Diacon. hiſt. Roman. lib. 8, in Phocâ.].

At the same time several signs appeared, portending the death of the Emperor (Maurice) [Imperatoris (Mauritii) mortem]. For first of all a very great comet was seen, flashing for very many days. Nicephorus [Nicephor.], book 18, chapter 35, in Lavatherus [lib. 18, c. 35, ap. Lavath.]. Note: Rockenbach seems to repeat the same comet under the year 603; or certainly the one he assigns to the year 601 will be the one that Calvisius ascribes to the year 599; for according to Calvisius [Calviſio], Maurice was killed in AD 602 [Anno Chriſti 602], on November 23 [Novembr. 23.].

[Margin: Cometagladii nitore.] *A comet with the brightness of a sword.* In AD 602 [A.C.602] a Xiphias was seen, that is [h.e.], a star with the brightness of a sword, without any rays, on the same night on which the Emperor Maurice [Mauritius Imper.] dreamed that he was being handed over to his own soldier Phocas [Phocæ militi ſuo] to be slaughtered. Zonaras, on Maurice [in Mauritio]. Eckstorm [Eckſtorm.]. Under this emperor, moreover, as Prætorius and Riccioli hold, Mahometus was born, at which time a hairy star [Crinitum Sidus] appeared for 6 months.

AD 604. [Anno Chriſti 604.]

[Margin: Bini Cometæ uno anno conſpecti ſunt.] *Two comets seen in one year.* In the time of Pope Sabinian I [Papæ Sabiniani I] (who, according to Calvisius [Calvif.], held the see in AD 604 [an. C. 604]) a very bright comet was seen, and at Byzantium [Bizantii] a four-footed boy is born. Platina, p. 74 [pag. 74,]. Nauclerus.

In the year 604 [Anno 604], while Theudebert [Theudeperto], King of the Franks, was ruling among the Gauls [apud Gallos], a star appeared in the sky in the months of April and May, which we call a comet, etc. Later in the same year [Eodem deinceps anno], in the months of November and December, a comet appeared again. Lycosthenes [Lycoſth.]. Eckstorm [Eckſt.], however, refers these comets to the next year, 605.

AD 615. [Anno Chriſti 615.]

About AD 613 [Circa an. C. 613] a comet [Cometes] appeared for a month; at that time Cosroas (or Cosdras) [Coſroas (vel Coſdras)], King of the Persians, plundered Jerusalem [Hieroſolymam]. Lavatherus [Lavath.], from Polydor Vergil. [ex Polydor Vergil.]. Myzaldus reports this one among the comets of Venus [inter Cometas Venereos], p. 188 [pag. 188.].

Cosroës plundered Jerusalem in AD 615 [an. C. 615], according to Calvisius [Calvif.]. D. Christiani seems to move this comet to AD 620 [in annum C. 620]. Rockenbach to the year 617, and likewise [itidemq́;] the *Centur. Magd.*

[Centur.Magd.], Cent. 7 [Cent.7], and Polyd., book 3, *Prodig.* [Polyd. lib. 3, Prodig.]. Lycosthenes [Lycoſth.].

AD 632 or 633. [Anno Chriſti 632 vel 633.]

[Margin: Cometagladii formam referens.] *A comet showing the form of a sword.* In AD 633 [A. C. 633] a sign was seen in the sky, having the form of a sword, which stood towards the south for 30 days. Funccius [Funcc.], from the *Annal. Conſtantin.* [ex Annal. Conſtantin.]. Lavatherus [Lavath.]. Rockenbach, Lycosthenes [Lycoſthen.].

Riccioli refers the same one to the year 632, from Petrus Surdus [Petro Surdo] and Spontanus [Spontano]. Spondanus has it under AD 632 [ad annum C. 632], the 7th of Honorius [Honorii 7], from Theophanes [ex Theophane]. Eckstorm [Eckſtormius], however, places the same comet in the year 631, from Schosserus [ex Schoſſero].

In the year 632 [A. 632] there was an earthquake, for 30 days: a sign appeared in the sky in the manner of a sword [in modum gladii]. Sigebertus [Sigebert.].

About AD 669 or 673, 676. [Anno Chriſti 669 vel 673, 676 circiter.]

[Margin: Cometa 3 Menſ. inſtar Columnæ.] *A comet of 3 months, like a column.* Under Pope Adeodatus [Papa Adeodato]: That haired star, which the Greeks call a comet, and which appeared for three continuous months, surely indicated so many disasters and so many evils [tot clades totq́; mala]. Platina: and from here Lavatherus [Lavath.], Rockenbach [Rockenb.], who says that this Pope died then [tum diem ſuum obiiſſe], in the fourth year of his pontificate. But according to Calvisius this Pope was elected in the year 669; having sat for 7 years and almost three months, he dies in the year 676. Where Calvisius [Calviſ] adds: When this Pope had been elected, in the month of August, a comet appeared in the east for three months, whose rays pierced the sky; afterwards it vanished. Anastas. [Anaſtaſ.].

In the year 673 [Anno 673] a flame was seen for 10 days, to the very great terror of the peoples. In the fourth year after [Ann.quarto poſt], another comet appeared for three months. Eberus, D. Christiani and Myzaldus [Eber9.D.Chriſt.&Myz.].

In the year 676 [Anno 676] Lavatherus and Funccius report, from Palmerius [ex Palmerio], a comet with very great rays, seen for three months. Prætorius, from Orosius [Ex Oroſio]. Rockenbach and the *Centuriat. Magdeb.* 7 [Centuriat. Magdeb. 7] refer the same one to the year 677, to the eighth year of Constantine [ad annum Conſtantini octavum], from Sigebertus [Sigebert.] and Paul. Diac., book 9 [Paul. Diac. lib. 9]; Bede [Beda] to the year 678, according to

Riccioli [Ricciolum]. Myzaldus has it that in the year 676 [anno 676] a comet appeared for three months, from cockcrow until the rising of the Sun, in the eastern region [in orientali tractu].

[Margin: Cometa tres menſes duravit.] *A comet lasted three months.* In the year 677 [Anno 677], from August, for three months, a star piercing the heavens

[cœlos] with its rays appeared from the direction of the east, from cockcrow until morning. Sigebertus, *Fasc. Temp.* [Faſc. Temp:] and Spangenb., *Chron. Sax.*, chapter 69 [Spangenb: Chron: Sax: cap:69.]. Eckstorm [Eckſtormius] adds that it bore before it a lofty flame like a column. Likewise from Sigebertus, *Ecclesiastical History* [Hiſt. Eccleſ:], century 7, chapter 13 [cent: 7, cap: 13.]. Spondanus refers this comet, which appeared for three months, to AD 678 [ad annum Chr: 678], in which Pope Donus [Papa Donus] died; and this, as he says, from Anastasius [ex Anaſtaſio] and Bede, book 4, chapter 12 [lib: 4, c: 12.].

In AD 676 [A.C. 676] a star with very great rays appeared for three months. Palmerius, Lycosthenes [Lyc.].

AD 684. [Anno Chriſti 684.]

[Margin: Cometa obtuſo lumine inſtar Lunæ.] *A comet with a dull light, like the Moon.* In AD 684 [A. C. 684] a comet appeared for three months. Lavatherus [Lavath:], from the *Chron. Norimb.* [ex Chron: Norimb:]. Franck. [Franck:], from Schosserus [ex Schosſero]. There are some who write that in the times of Pope Benedict [Benedicti Papæ] a star appeared near the Pleiades [juxta Vergilias] for some days and nights, in a clear sky, between the Nativity of the Lord [natalem Domini] and Epiphany. Platina [Platin:], p. 87. According to Calvisius [Calviſ:], this Benedict held the see in AD 684 and 685 [an: Ch: 684 & 685]. D. Christiani [D. Chriſt:] refers the same one to the year 687, in the reign of Constantine Pogonatus [Imperante Conſtantino Pogonato] (who, however, according to Calvisius [Calviſio], already dies in the year 685), and adds that it was of such a form as is that of the Moon showing through a thin little cloud [per nubeculam tenuem transparentis].

In AD 684 [A. C. 684] a star appears by night near the Pleiades [juxta Vergilias], in a clear sky, between the Nativity of Christ and the Theophany [Theophaniam], with a dull light, like the moon; and on the 14th day of February [die 14 Februar:] that star went out in the evening from the south toward the north [à meridie ad Septentrionem]. Calvisius [Calviſ:], from Anastasius [ex Anaſtaſio]. Between the years 684 and 694 [Intra annum 684 & 694] a great star appeared in the east. *Fascicul. Temp.* [Faſcicul: Temp:]. Lycosthenes refers this star, horrible (as he says) [horrendam (ut ait)], to the year 687 [ad annum687].

AD 729. [Anno Chriſti 729.]

In AD 722 [Anno Chriſti 722] two comets were seen in the sky in the month of January, for 15 days, of which one went before the Sun in the morning, the other followed it in the evening. Lavatherus, from Aug. Niphus [ex Aug: Nipho]. But he says that Palmerius places them in the year 729, and says that Paulus Æmilius [Paulum Æmilium] reports from Bede: At the time when the most savage plague of the Saracens [ſævisſima Saracenarum lues] was laying waste the Gauls [Gallias], two comets shone for twice seven days, one going before the Sun in the morning, the other following in the evening, facing the north [Aquilonem] with a fiery torch. Thus Æmilius, from Bede, is cited by Myzaldus,

Spondanus [Sic Æmilium ex Beda citat Myzaldus, Spondanus.]. Calvisius also refers both these comets to the year 729, and Platina one of the two [alterum], under Pope Gregory II [ſub Papâ Gregorio II.]. Although Riccioli thinks that the same comet was seen both in the morning and in the evening because of its rather large declination [ob majuſculam declinationem]. The same author says that these comets are moved back by Cardanus [à Cardano] to the year 726, book 2, *de Judic. Astor.*, text 53 [l. 2, de Judic: Aſtor: text: 53,], and by Vincent. Guinisius [à Vincent: Guiniſio] to the year 725. [Margin: Vnicus tantummodo Cometa hoc anno apparuit,teſte Appiano.] *Only a single comet appeared this year, on the testimony of Apian.* Apian [Appianus], however, in the *Astronomicum Caesareum* [in Aſtronomico Cæſario], chapter 16, on the comet of the year 1531 [de Comet: anni 1531.]. He says there was one comet, which Palmerius judged to be twin [geminum]. Tadeáš Hájek [Thaddæus Hagecius] also thinks so, in the *Apodixis Physica & Mathem. de Com.* [in Apodixi Phyſicâ & Mathem: de Com:], p. 19

In the year 729 [A. 729] two comets were seen in the sky in the month of January for 15 days, of which one went before the Sun in the morning and the other followed in the evening. Palmerius.

In AD 729 [A. C. 729] comet stars [Cometæ Stellæ] appeared. Lambert. Schaffnabrug. [Lambert: Schaffnabrug:].

Two comets appeared, and were memorable for this reason, that one went before the rising Sun, the other followed the setting one. Lycosthenes [Lycoſth.].

In AD 729 [A. C. 729], when Leo the Isaurian [Leone Iſauro] was Emperor of the East, two comets appeared near the Sun in the month of January. For one went before the rising Sun in the morning [Solem præcedebat manè orientem], the other followed the setting Sun in the evening, as if foretelling a dire disaster to the East and the West alike [quaſi orienti ſimul & occidenti diræ cladi præſagi]. They carried a torch of fire toward the north [contra Aquilonem], sloping upward, as if for kindling [quaſi ad accendendam acclivem]; and they appeared in the month of January and remained for nearly two weeks [duabus fermè Septimanis]. Eckstorm, from the *Ecclesiastical History*, century 8, chapter 13 [ex Hiſt: Eccleſ: cent: 8, cap: 13,], from Bede, book 5, chapter 24 of the *English History* [ex Bedâ lib: 5, cap: 24 Hiſtor: Anglicæ.].

AD 745. [Anno Chriſti 745.]

In the year 745 [A. 745] a comet appeared in Syria. Funccius [Funcc.]. Riccioli [Ricciol:] adds: toward the end of the year. Rockenbach [Rockenb:], Lavatherus [Lavath:], Lycosthenes [Lycoſth:], Eckstorm, from Sigebertus [ex Sigeberto], Prætorius.

AD 761. [Anno Chriſti 761.]

[Margin: Cometa ex orientali occidentalis factus eſt.] *From an eastern comet it became a western one.* In AD 761 [A. C. 761] a comet was seen in the east

for 10 days, and another, appearing for 21 days, afterwards followed it in the west [quem deinde alius … in occidente ſecutus eſt]. Funccius [Funcc:], Rockenbach [Rockenb.], Lavatherus [Lavath:], Lycosthenes. Eckstorm, from the *Ecclesiastical History*, century 8, chapter 13 [ex Hiſt: Eccleſ: cent: 8,cap: 13:]: A comet shone forth this year 761, which appeared both in the eastern region [in orientali plagâ] and afterwards in the western. Calvisius [Calviſ:], from Cedrenus [ex Cedreno]. Riccioli thinks it was one [unum fuiſſe].

AD 763. [Anno Chriſti 763.]

[Margin: Cometa inſtar trabis.] *A comet like a beam.* In AD 763 [A. C. 763], in the twenty-second year of the reign of Constantine [anno vigeſimo ſecundo Imperii Conſtantini] in the East a comet appeared. Rockenbach. Riccioli [Ricciol.]. The Rithmi Germanici have it that this was called a Docetes [Doceten hunc dictum], and was of the shape of a beam [Trabis figura]. In the year 763 [An. 763] a comet, a Docetes, appeared in the East. Lycosthenes, Prætorius.

AD 800. [Anno Chriſti 800.]

A comet is also ascribed to the year 800 [Anno quoque 800]; in the following year came the accession of Charlemagne [Caroli Magni] to the Empire [ad Imperium], and his rule lasted 14 years [cujus gubernatio 14 annos duravit]. In the last year of it, namely in AD 815 [anno C. 815], a remarkable and terrible comet appeared, foretelling the death of Charles. Prætorius, and from him Riccioli. According to Calvisius, however [Iuxta Calviſium autem], Charles was indeed declared Emperor at the Christmas festival [in Natalitiis] of the year 800, but dies in the year 814, January 28 [814,Januar.28], when he had reigned only one month beyond 13 years.

About AD 814. [Anno Chriſti 814. circiter.]

[Margin: Horribilis Cometa luce & ſpecie mirabili.] *A horrible comet, wonderful in light and appearance.* In AD 414 [A. C. 414], before the death of Charlemagne, a comet appeared, singular and terrible. Lavatherus [Lavath.], Lycosthenes [Lycoſth.], Rockenbach [Rockenb.].

In the year 824 [An. 824], when a horrible comet had been seen, the Emperor of Rome [Romæ Imperator] died in the same year. Lavatherus, from Suessanus [ex Sueſſano]. But perhaps the year 814 should be read [Sed fortè legendum anno 814.]. For the year AD 824 [annus Chr. 824] falls in the 9th year of Louis the Pious [Ludovici Pii], who nevertheless reigned 25 years.

In particular [Imprimis], in the times of Michael Caropalates [Michaëlis Caropalatæ], a comet appeared, wonderful in light and appearance. Others have referred this portent [oſtentum] to the times of Leo. The shape of this star is reported to have been like a double moon, visibly meeting and parting [perſpicuè concurrentis & diſcedentis]; and while diverse forms seemed to be fashioned, among these it also seemed to show itself [ſeſe viſum eſt exhibere] as the likeness of a man without a head. Joach. Camerar., *Append. Chronol.*

Nicephor., p. 54 [Joach. Camerar. Append. Chronol. Nicephor. pag. 54.]. According to Calvisius, Michael Curopalates was Emperor of Constantinople [Imperator Conſtantinopol.] in AD 812 and 813 [A. C. 812 & 813]. And D. Christiani [D. Chriſtian.] assigns this comet to this year, at the Nones of November [ad Nonas Novembris]. And without doubt this is the same comet that is said to have preceded the death of Charlemagne, since according to Calvisius he died at the beginning of the year 814. Platina seems to refer this comet to the year in which Pope Leo [Leo Papa] died, namely AD 816 [ſcil. ann. Chriſti 816], according to Calvisius [juxta Calviſ.]. Alstedius has another comet in the year 818 [Anno 818].

AD 830. [Anno Chriſti 830.]

In AD 830 [Anno Chriſti 830] a comet was seen in the sign of Aries. Lavatherus [Lavath.], from *Spec.* [ex Spec.].

In AD 829 [Anno C. 829], as Tiornovellus reports, what were seen were falling stars rather than comets [viſæ ſunt Stellæ potius cadentes, quàm Cometæ], and they killed cattle and some people [pecudes & homines quosdam]. And in the same year a rain-stone [lapis pluvialis] fell from the sky, 4 feet in length. Riccioli [Ricciol.].

AD 837. [Anno Chriſti 837.]

[Margin: Cometa retrogradus.] *A retrograde comet.* In AD 837 [A.C. 837], about the feast of Easter [Circa feſtum Paſchatos], a comet appears in the sign of Virgo; in the space of 25 days it passed through Leo, Cancer and Gemini, and at last vanished in the head of Taurus. Calvisius [Calviſ.], from Aimoinus [ex Aimoino]. D. Christiani seems to refer the same comet to the year 839. In AD 839 [A. C. 839], he says, about the feast of Easter a comet appeared in the sign of Virgo, in that part where its feet touch the tail of the serpent and the raven [caudam ſerpentis corvumq́;]. And since it made for the east not in the manner of the seven wandering stars [cùm non more errantium ſeptem Stellarum orientem peteret], passing through Leo, Cancer and Gemini for 25 days, at last, in the head of Taurus, under the feet of the Charioteer [ſub Aurigæ pedibus], it laid down its fiery globe and the length of its darting rays [igneum globum,vibrarumq́; prolixitatem], which it had stretched out in every direction [quas usq́ue quaq́ue porrexerat].

In AD 837 [Anno C. 837] Pepin [Pipinus] died, a comet having gone before [præcedente Cometâ]; although others put this one forward [protrahant] to Louis the Pious [ad Ludovicum Pium], who died in the year 840, and they say that in the year 839 a comet shone forth [præfulſiſſe] in the sign of Aries. Riccioli [Ricciol.]. According to Calvisius [Juxta Calviſium], Pepin dies in the year 838; Louis the Pious in the year 840. Spondanus reports that the Emperor Louis [Ludovicum Imperatorem] did indeed fear for himself from the comet of the year 837, but died only in the year 840 [anno demum 840].

AD 838. [Anno Chriſti 838.]

In AD 838 [A. C. 838] a comet appeared in the sign of Libra. Myzaldus [Myzald.], in *Catalog.* [in Catalog.]. Rockenbach [Rockenb.], from Sigebertus [ex Sigeberto]. Lycosthenes. Perhaps the same as the preceding one; although in Lycosthenes [apud Lycoſth.] none is found in the year 837. Eckstorm [Eckſtormius] reports that on the 11th day of April [die 11 April.] a horrible comet was seen for 25 days on end.

AD 839. [Anno Chriſti 839.]

In AD 839 [A. C. 839] a comet appeared in the sign of Aries. Myzaldus [Myzald.]. Rockenbach [Rockenb.], together with very frequent trajections [unà cum frequentiſſimis trajectionibus]. Prætorius [Prætor.], before the death of Louis the Pious [ante mortem Ludovici Pii].

[Margin: Bini Cometæ ſimul.] *Two comets at once.* In AD 8[?]9 two comets are said to have appeared, each of huge mass [uterque ingenti mole], horrible to human sight [humano aſpectui horrendus]. One went before the rising Sun in autumn, the other followed the setting Sun in spring [in Vere]. Fiery battle lines [ignitæ acies] were also seen, and rather often, toward nightfall [ſub noctem], clashing in the sky with burning spears, and then, one side being routed [alterâq; profligatâ], suddenly vanishing. Hector Boëtius, book 9, fol. 200 [lib. 9, fol. 200.]. Perhaps they are the same as the comets of the years 838 and 839 noted above.

In AD 839 [A. C. 839] a comet appears in the sign of Aries, and for some days very many little fires [igniculi] are seen to run about the sky like stars. Sigebertus, Lycosthenes, Eckstorm [Sigeb. Lyc. Eckſt.].

AD 842. [Anno Chriſti 842.]

In AD 842 [A.C. 842] a comet appeared in Aquarius. Sigebertus [Sigebert.]. Myzaldus, in *Catal.* [in Catal.]. Rockenbach. Funccius, Prætorius, who adds that in the following year not a few comets appeared, when the Emperor Lothair [Lotharius Imperator] was waging a deadly war with his brothers. Lavatherus says the same, from Franck. and the *Chron. Carion.* [Lavath. ex Franck. & Chron. Carion.]. Eckstorm [Eckſtorm.], from the *Ecclesiastical History*, century 9, chapter 13 [ex Hiſt. Eccleſ. cent. 9, cap: 13,], from Sigebertus [ex Sigeberto],

AD 844. [Anno Chriſti 844.]

[Margin: Cometa altior Venere.] *A comet higher than Venus.* In AD 844 [A. C. 844] Abū Maʿshar [Albumaſar] observed a comet above Venus [ſupra Venerem], as Cardanus reports, book 4, *Subtil.*, p. 207 [l. 4, Subtil: p. 207], Tycho, vol. 1, p. 783 [Tom. 1, pag: 783], Cysat [Cyſatus], p. 56, Riccioli [Ricciol:], Eckstorm [Eckſtorm:], from the *Chronicon Sax.* [ex Chronico Sax.], Spang., chapter 134 [Spang: cap. 134.].

AD 868. [Anno Chriſti 868.]

In AD 868 [A.C. 868] an earthquake occurred and a comet appeared. Lavatherus [Lavath.], from Hermann. Contract. [ex Hermann: Contract:]. In the following year King Lothair [Lotharius Rex], brother of the Emperor Louis [Ludovici Imperatoris], dies. Rockenbach [Rockenb:] has the same; he, however, wrongly repeats the same comet, with the same consequences, under the year AD 968 [ad annum C. 968].

In AD 868 [A. C. 868], in the 28th year of Louis IV [Ludovic. IV, anno 28], an earthquake occurred and a comet was seen. Herm. Contract. [Herm: Contract:], Lycosthenes [Lycoſthen:]. In AD 869 [A. C. 869] a comet was seen very plainly [manifeſtisſimè]. Mar. Scot., book 3, p. 442 [Mar. Scot: lib: 3, pag: 442,], Sigebertus [Sigebert:], Eckstorm [Eckſtorm:], from Schosserus [ex Schosſero].

AD 875. [Anno Chriſti 875.]

[Margin: Cometa longisſim[[â/á]] caudâ.] *A comet with a very long tail.* In AD 874 [A. C. 874] a huge star [Ingens ſidus], going before the moon for the whole month of April, with fiery rays stretched out lengthwise [ignitis radiis in longum protenſis], was seen by night and by day, not without dread [non ſine horrore]. Hector Boëtius [Hector Boetius], book 10, fol. 208.

In AD 875 [A. C. 875] a comet appeared on the 6th day of June [die 6 Junii], sparkling more than is normal [plus juſtò ſcintillans] and throwing out long hair [longas Comas projiciens]. Calvisius [Calviſ.], without an author [ſine autore]. [Margin: Cometa ſolit[[ò/ó]] rutilantior.] *A comet redder than usual.* In the year 876 [A. 876], on the eighth day before the Ides of October [Octavo Idus Octobris], such a portent [tale oſtentum] occurred again; Prætorius. In the year 876 [A. 876] a comet appeared, glowing redder than its usual form [formâ ſolitâ rutilantior]. Rockenbach [Rockenb:], Myzaldus [Myzald:], in *Catal.* [in Catal.]. In the year 876 [A. 876.] a comet [Cometes] appeared redder than usual [ſolito rutilantior]. Sigebertus [Sigebert:], Lycosthenes [Lycoſth.]. In the year 876 [A. 876], in the month of June, a comet was seen for several nights, glowing a horrible red [horribiliter rubens]: Eckstorm [Eckſt:], Spang., *Chron. Sax.*, chapter 107 [Spang: Chron: Sax. cap. 107,], from Sigebertus [ex Sigeb.].

AD 882. [Anno Chriſti 882.]

In AD 882 [A. C. 882] a comet appeared on the 18th day of January [die Ianuar. 18], with a long tail [cum prolixâ caudâ]. Calvisius [Calviſ.], from Sigebertus [ex Sigebert.]. Rockenbach [Rockenb.]. Eckstorm [Eckſtorm.], from Spang., *Chron. Sax.*, chapter 110 [ex Spang. Chron. Sax. cap. 110.]. Note: Sigebertus does not have this comet, but only some events [res geſtas duntaxat aliquas], which Calvisius appends [ſubnectit]. Alstedius [Alſted.].

In AD 882 [A. C: 882], on the 15th day before the Kalends of February [15 Calendarum Februarii], a haired star [Sydus crinitum] was seen. Lycosthenes [Lycoſthen.], Prætorius [Prætor.].

AD 902. [Anno Chriſti 902.]

In AD 902 [A. C. 902] a comet appeared, with its tail thrown out toward the east [caudâ versùs orientem projecta], which shone for 40 days. Calvisius [Calviſ.], from Cedrenus [ex Cedreno]. Eckstorm [Eckſtorm.], from Schosserus [ex Schosſero].

AD 905. [Anno Chriſti 905.]

In AD 905 [A. C. 905], in the month of May, a comet appeared; shortly afterwards Louis, King of the Lombards [Ludovicus Rex Longobardorum], son of Boso [filius Boſonis], was deprived of his eyes [oculis orbatus eſt] by Berengar, the Italian Emperor [à Berengario Imperatore Italico]. Lavatherus [Lavather.], from the *Annal. Helvet.* of Stumphius [ex Stumphii Annal. Helvet.]. Rockenbach [Rockenb.], Lycosthenes [Lycoſthen.]. But in fact this Louis [At verò Ludovicus iſte] was deprived of his eyes in AD 903 [anno C. 903], according to Calvisius [Iuxta Calviſium]. Hence perhaps this is the same comet as the one that Calvisius refers to the year 902.

In the year 904 [A. 904], in the month of May, a comet star [Cometæ Stella] appeared, and in the month of August this change took place (by which Louis was deprived by Berengar of his kingdom and his eyes) [quâ Ludovicus à Berengario regno & oculis privatus eſt]. Regiomon., *Chron.*, book 2, p. 72 [Regiomon. Chron. lib. 2, p. 72.].

About AD 908, or 912. [Anno Chriſti 908 circiter vel 912.]

[Margin: Cometa ſolit[[ò/ó]] rutilantior.] *A comet redder than usual.* In AD 912 [A. C. 912] comets were seen; King Rudolf [Rudolphus Rex] died; the Hungarians [Hungari] were laying Germany waste. Herm. Contract., in Lavatherus [Herm. Contract. apud Lavath.]. After these times (of Pope Christopher [Papæ Chriſtophori]) fiery torches [igneæ faces] in the sky and stars twinkling and running about [ſtellæ micantes discurrentesq́;] were seen beyond what is customary [præter conſuetudinem], etc. And a comet appeared redder than usual [ſolito rutilantior]; and an excessive flood of waters [nimia inundatio Aquarum] followed. Lavatherus, from the *Chron. Norimberg.* [Lavath. ex Chron. Norimberg.]. Lycosthenes, in the year 912 [anno 912]. Christopher [Chriſtophorus] seized the pontificate [Pontificatum invaſit] in the year 907, and held it until the following year, 908. The Hungarians lay Germany waste in the year 909. [Margin: Cometa rubicundus.] *A ruddy comet.* This seems to be the same comet as the one in Prætorius [de quo Prætorius]: In the year 906 [Anno 906] a comet appeared redder than is customary [præter morem rubicundior], which was followed by great rains. Thus, nearly, Alstedius too [Ita ferè & Alſtedius]. Eckstorm, from the *Ecclesiastical History*, century 10, chapter 13 [Eckſtorm. ex Hiſtor. Eccleſ. cent. 10, cap. 13.].

Myzaldus reports a comet seen in the sign of Scorpio in AD 913 [A. C. 913], p. 170. In AD 912 [A. C. 912], in the 1st year of Conrad VIII [anno 1 Conrad. VIII], comets are seen. King Rudolf [Rudolfus Rex] died. Herman. Contract.

AD 930. [Anno Chriſti 930.]

In AD 930 [A. C. 930] Myzaldus cites [adducit] a comet appearing in the sign of Cancer, p. 166. Eckstorm [Eckſtormius].

AD 942. [Anno Chriſti 942.]

In AD 941 [A. C. 941] comets were seen for 14 nights around Constance [circa Conſtantiam], a city of Upper Germany [Germaniæ ſuperioris Urbem]; the death of Pope Leo VII [Leonis VII Papæ] follows. Rockenbach [Rockenb.], Lycosthenes [Lycoſthen.], Lavatherus [Lavath.], from Hermann. Contr. [ex Hermann: Contr.], but under the year 942 [Sed ad annum 942.]. According to Calvisius [juxta Calviſium], Leo VII dies in the year 939; according to Hermann. Contract., in the year 938.

In AD 942 [A. C. 942] a star like a comet [Sidus ſimile Cometæ] was seen for 14 nights, and an immense mortality of cattle [immenſa mortalitas boum] followed. The *Chronic.* of Regino, append., p. 77 [Reginonis Chronic. append. pag. 77.].

In AD 942 [A. C. 942], in the sixth year of Otto the Great [anno ſexto Ottonis Magni], comets appear for 12 nights, and a mortality of animals [mortalitas animalium] occurred. Herm. Contract.

In AD 942 [A. C. 942] a comet appeared from the 15th day before the Kalends up to the Kalends of November themselves [à 15 Calendarum usque ad ipſas Calendas Novembris]. Eckstorm, from the *Ecclesiastical History*, century 10, chapter 13 [Eckſtorm. ex Hiſtor: Eccleſ: cent. 10, cap. 13.].

AD 944. [Anno Chriſti 944.]

[Margin: Cometa miræ magnitudinis.] *A comet of wonderful size.* In AD 945 [A. C. 945] a comet of wonderful size [miræ magnitudinis] appeared in Italy. Funccius and Lavatherus, from Antonin. and Urspurg. [ex Antonin. & Urſpurg:]. Lavatherus [Lavath.] adds: in the 7th year of Otto I [anno 7, Ottonis I], which according to Calvisius coincides with AD 942 [anno C. 942]. D. Christiani [D. Chriſt.], in the same year 945. He records a new star seen near Cassiopeia [Stellam novam propè Caſſiopeam viſam recenſet]. Rockenbach refers the same comet to AD 944 [ad annum Chriſti 944]; likewise Myzaldus, in the *Catalogus* [in Catalogo]. Urspurgensis has it at p. 212, under the year 945 [Urſpurgenſis habet pag. 212 ad annum 945.]. Otto himself, however, comes to the empire [ad imperium accedit] in the year 937.

In AD 944 [A. C. 944] a comet of wonderful size appeared in Italy, portending the famine that followed. Sigebertus [Sigebert.], Lycosthenes [Lycoſthen.].

In AD 944 [A. C. 944] a comet of wonderful size and length [miræ magnitudinis & proceritatis] appeared in Italy, spreading fiery rays [igneos diffundens radios]. Eckstorm, from the *Ecclesiastical History*, century 10, chapter 13 [Eckſtorm: ex Hiſt: Eccleſ: cent: 10, cap. 13.].

AD 962. [Anno Chriſti 962.]

In AD 962 [A. C. 962], in the reign of Otto [Imperante Othone], a comet of unusual size [inſolitæ magnitudinis] was seen in Italy. Lavatherus, from the *Chron. Norimb.* and Sebast. Franck. [Lavath. ex Chron: Norimb. & Sebaſt. Franck.]. Yet he thinks it is the same as the one recorded in the year 945 [anno 945], since each was believed to be the herald of the famine that followed [famis ſequentis nuntius].

AD 975. [Anno Chriſti 975.]

[Margin: Cometa per 8 Menſes apparuit.] *A comet appeared for 8 months.* In AD 975 [A.C.975] a comet was seen in the month of August, for eight whole months [per totos octo menſes]. Calvisius, from Cedrenus [Calviſ: ex Cedren:]. Rockenbach, Lycosthenes [Rockenb: Lycoſthen:]. Eckstorm, from Schosserus [Eckſtorm: ex Schosſero].

In AD 971 [A. C. 971], in the 35th year of Otto I [Othon. I anno 35], a certain sign of fiery colour [Signum quoddam ignei coloris] appeared in the sky. Hermann. Contract. Marianus Scotus, book 3, p. 448 [Marian.Scotus l.3, p. 448.]. Abb. Stadens. [Abb. Stadenſ.]. Lycosthenes refers it to the year 969 [ad annum 969 illud refert].

AD 983. [Anno Chriſti 983.]

In AD 983 [A. C. 983], or thereabouts, before the death of the Emperor Otto II [ante mortem Imperatoris Ottonis II], a comet appeared. Prætorius, Lycosthenes. Platina mentions a comet under Pope John XVI [ſub Johanne XVI Papa], p. 137.

About AD 1000. [Anno Chriſti 1000. circiter.]

In AD 1000 [A. C. 1000], besides other prodigies [præter alia prodigia], a comet was seen for some time [aliquandiu], and a terrible earthquake [terræ motus horribilis] followed; three years later the Emperor Otto III was carried off by poison [veneno ſublatus eſt]. Eberus. According to Calvisius, Otto died in AD 1002 [anno C. 1002].

In AD 999 [A. C. 999], and in the 16th year of Otto [& XVI Ottonis anno], many prodigies were seen everywhere [pasſim]: a very great earthquake occurred [Terræ motus factus eſt permaximus], and a terrible comet appeared, on the 19th day before the Kalends of January, around the 9th hour [19 Calend. Jan. circa horam IX]. Wolf., from the *Chron. Saxon.* [Wolf. ex Chron. Saxon.]. Sigebertus reports the same words under AD 1000 [ad A.C. 1000], the 17th of Otto [Othonis 17]. Likewise Nauclerus reports this portent [hoc portentũ] in the same words, about the year 1000. Before and after the death of this Otto [hujus Othonis], many prodigies seen throughout Germany are listed [prodigia per Germaniam viſæ enumerantur multa]: earthquakes [terræ motus], comets [Cometes], torches burning in the air by day [ardentes in aëre faculæ interdiu].

H. Mutius, *Chron. German.*, book 14, p. 108 [H. Mutius Chron. German. lib. 14, p. 108.].

In AD 1000 [A. C. 1000] a haired star of dreadful size [Stella crinita horrendæ magnitudinis] was seen in the sky; a fiery torch [fax quoq; ignea] also fell from the sky, and a fiery serpent [ſerpens igneus] was seen in the air. Eckstorm [Eckſt.], from Büntingus [ex Büntingo].

About AD 1005. [Anno Chriſti 1005 circiter.]

In AD 1005 [A. C. 1005], in the 3rd year of Henry the Saint, or the Lame [anno 3 Henrici Sancti ſeu Claudi], who began to reign in AD 1003 [anno C. 1003], a comet terrible to look at [horribilis aſpectu] appeared, scattering flames this way and that [flammas huc atque huc diſpergens]. Lavatherus, from the *Chron. Norinb.* and Antoninus [Lavath: ex Chron: Norinb: & Antonino]. Under the Emperor Henry I (whom others call II [I I]), they write that a comet appeared in the south [in meridie], etc. Lavatherus, from Camerar. and Vitus Amerbach [Lavath. ex Camerar. & Vito Amerbach]. Lavatherus [Lavather.] reports the same comet as recorded under AD 1004 [ad annum Ch: 1004] by Urspurgensis [ab Urſpurgenſi], under 1006 by Palmerius and Suessanus [à Palmerio & Sueſſano], and under 1007 by Franck [à Franck.].

[Margin: Cometa Auſtralis.] *A southern comet.* In AD 1006 [A. C. 1006] a comet flashed out [emicuit] in the southern part of the sky [in Auſtrali cœli parte]. Eberus.

In AD 1005 [A.C. 1005] a comet of fearsome appearance [formidabili ſpecie], wandering this way and that [huc & illuc oberrans], was seen in the southern part. Myzaldus, in the *Catalog.* [in Catalog.]. Eckstorm, from the *Ecclesiastical History*, century 11, chapter 13 [Eckſtorm: ex Hiſt: Eccleſ: cent: 11, cap: 13.]. Sigebertus.

[Margin: Cometa horribilis.] *A terrible comet.* In AD 1005 [A. C. 1005] a comet terrible to look at [aſpectu horribilis] was seen for thirteen nights, at the feast of Easter [feſto Paſchali]. Prætorius. According to Calvisius, Henry the Saint [Henricus Sanctus] came to the empire [imperium accesſit] in AD 1002 [A. C. 1002]; hence his third year coincides with AD 1005 [anno C. 1005].

In AD 1005 [A. C. 1005], in the 2nd year of Henry [anno II Henrici], a comet was seen as a terrible one on the Kalends of October [Calendis Octobris horribilis viſus] and, tossing flames this way and that [flammasq; huc illuc jactitans], was observed in the southern part of the world [in parte mundi Auſtrali]. Rockenbach.

In AD 1004 [A. C. 1004] a comet appeared for a long time [longum tempus]. Urspurgensis, p. 214 [Urſpurgenſis pag: 214.].

In AD 1006 [Anno C. 1006] a comet flashed out in the southern region [in Auſtrali plagâ]. Palmerius.

In AD 1005 [A. C. 1005], in the 3rd year of Henry the Saint [anno 3 Henrici ſancti], on the first of October [primo Octobris], a comet of terrible appearance

[horribili ſpecie], tossing this way and that [huc illucq́; jactans], was seen in the southern part. Sigebertus [Sigebert.]. Lycosthenes.

AD 1009. [Anno Chriſti 1009.]

In AD 1009 [A. C. 1009], the year in which there died John XVIII [Johannes XVIII], or as others say, XIX

Pope [Papa], a terrible comet appeared toward the south [versùs meridiem]. Riccioli, from Cardanus, book 2, *De Judic.*, text 54 [Ricciolus ex Cardano, l. 2, de Judic: text: 54.].

In AD 1009 [A. C. 1009], toward the end of May [ſub finem Maji], a comet shone. Eckstorm, from the *Ecclesiastical History*, century 11, chapter 13 [Eckſtorm: ex Hiſt: Eccleſ: cent: 11, cap: 13.]. Sigebertus.

AD 1017. [Anno Chriſti 1017.]

[Margin: Cometa per 4 Menſes fulſit inſtar Trabis.] *A comet shone for 4 months like a beam.* In AD 1017 [A. C. 1017], in the 15th year of Henry the Saint [anno 15 Henrici Sancti], a comet more wonderful than usual [ſolito mirabilior] appeared for four months in the manner of a very great beam [in modum trabis maximæ]. Sigebertus, Lycosthenes, Myzaldus [Sigebert: Lycoſth: Myzald.]. D. Christiani [D. Chriſtian:]. Herlicius notes that this comet appeared in Leo [in Leone]. Eckstorm [Eckſtormius].

AD 1027. [Anno Chriſti 1027.]

In AD 1027 [A. C. 1027], after the shining of the comet [Poſt Cometis fulſionem] there was so dire a plague that the living were not enough to bury the dead, says Petrus Surdus in Riccioli [apud Ricciol:]. But in Calvisius [apud Calviſium] a violent plague in Germany is recorded in AD 1020 [anno C. 1020].

AD 1031. [Anno Chriſti 1031.]

In AD 1031 [A. C. 1031], D. Christiani notes that a comet shone before the death of Robert, King of the Burgundians [Roberti Burgundiorum Regis]. According to Calvisius, Robert, King of France [Robertus Rex Galliæ], dies in the year 1033. Alstedius [Alſt:] also assigns a comet to the year 1031 [Anno 1031 quoq́ue], and so does Eckstorm [nec non Eckſt.].

In AD 1038 [A. C. 1038] D. Christiani reports a comet before the death of the Emperor Conrad [Conradi Imperatoris]. Alstedius. According to Calvisius, Conrad dies in the year 1039, on June 4 [Junii 4].

AD 1042. [Anno Chriſti 1042.]

[Margin: Cometa retrogradus.] *A retrograde comet.* In AD 1042 [A. C. 1042], on the 6th day of October [D. 6 Octobr:], a comet appeared for that whole month [toto illo menſe], advancing from east to west. Calvisius, from Cedrenus [Calviſ: ex Cedren:]. Eckstorm [Eckſtorm:].

In AD 1043 [A. C. 1043], in the 4th year of Henry III [anno 4 Henrici III], a comet with long and flaming hair [longos & flamineos crines] was seen in

the morning [manè]. Rockenbach, Lycosthenes [Rockenbach, Lycoſthen:]. According to Calvisius, on the death of Otto [mortuo Ottoni] in the year 1039, on the 2nd day of June [die 2 Junii], Henry III succeeds. Hence the fourth year of the reign [annus Imperii quartus] falls in the year 1042.

AD 1058. [Anno Chriſti 1058.]

In AD 1058 [A. C. 1058] a comet was seen in Poland, and the death of the king and a famine followed it [quem mors Regis & fames ſequutæ ſunt]. Funccius, Lavatherus, Rockenbach, Lycosthenes [Funcc. Lavath. Rockenb. Lycoſthen.]. Calvisius, from the *Hist. Polon.* [ex Hiſt. Polon.], records the death of Casimir, King of Poland [Caſimiri Regis Poloniæ], in the year 1058, on the 28th day of November [die 28 Novembr.].

AD 1066. [Anno Chriſti 1066.]

In AD 1066 [A. C. 1066] a comet shone out over the whole world at the feast of Easter [in feſto Paſchatos] for 14 nights. Funccius, Lavatherus, from the *Reb. gest.* of Stumphius, Henric. IV. [Funcc. Lavath. ex Stumfii Reb. geſt. Henric. IV.]. Myzaldus, in the *Catalog.* [Myzald. in Catalog.]. Spondanus.

[Margin: Cometa haud minor Lunâ.] *A comet no smaller than the Moon.* In AD 1066 [A. C. 1066] nearly all the writers mention one comet [Cometæ unius omnes ferè Scriptores meminerunt]. It appeared at the beginning of May [ineunte Majo], following the setting Sun. It was seen for 40 days. At first it was nearly equal to the Moon [Principiò ferè par Lunæ fuit]; then, when it took on a tail, its size decreased as the tail grew [eâ creſcente magnitudo ejus decrevit]. Calvisius, from Zonar. [Calviſ. ex Zonar.].

And that terrible comet [ille horribilis Cometa], which appeared in the year 1066 itself [ipſo anno 1066], around the days of Easter [circa dies Paſchæ], signified these evils [hæc mala ſignavit]. Abb. Stadens. [Abb. Stadenſ.].

In AD 1066 [A. C. 1066], at the Easter feasts [in Feſtis Paſchalibus], a comet appeared for nearly 14 continuous nights. Schafenburg, Lycosthenes.

In AD 1066 [A. C. 1066] a comet appeared throughout the whole Easter week [in tota paſchali hebdomada]. Sigebertus [Sigebert.].

In the year of Christ [Anno C.], in the sixth year of the Emperor Constantine Duc. [Conſtantini Duc. Imp. anno ſexto], in the month of May, there was seen a star [Stella], haired, at Constantinople [crinita Conſtantinopoli], following the setting Sun [Solem ſequens occiduum], which at first equalled the full Moon in size [initiò magnitudine æquavit Lunam plenam] and then, when its hair was growing out [cum coma enaſceretur], was diminishing [minuebatur]. [Margin: Com[[e/c]]ta [[a/æ]]qualis Lun[[a/æ]].] *A comet equal to the Moon.* It shone out [Effulſit] for 13 nights. Büntingius, from Zonar. [Büntingius ex Zonar.]. Eckstorm [Eckſtorm.].

AD 1067, or 1068. [Anno Chriſti 1067, vel 1068.]

In AD 1067 [A. C. 1067] a comet appeared in the sky. Lavatherus, from Palmerius and Suessanus [Lavath. ex Palmer. & Sueſſano]. D. Christiani [D. Chriſt.], who also records another, very fiery one [alium ignitisſimum] under the following year, 1068 [etiam ad ſequentem annum 1068 annotat], without doubt from Alstedius [ſine dubio ex Alſtedio].

The year [Annus] 1066 and 1068 are also famous on account of comets [propter Cometas celebres ſunt]. Prætorius.

In the year 1067 [Anno 1067] a comet appeared in the sky, Palmerius.

AD 1071. [Anno Chriſti 1071.]

In the year 1071 [Anno 1071] an unusual star [Stella inſolita] was seen toward the south and the west [in Auſtrum & Occidentem] for 25 days, and after other wonders [poſt alia miracula] a comet appeared, drawing long and flaming hair [longos & flammeos crines ducens]. Prætorius. D. Christiani [D. Chriſt.]. Alstedius. In almost the same words [Iisdem ferè verbis] Lavatherus refers a comet to the year 1106, and Lycosthenes to the year 1042.

AD 1096, or 1097. [Anno Chriſti 1096, vel 1097.]

[Margin: Cometa ſubobſcurus.] *A somewhat dim comet.* Around AD 1096 [Circa A. C. 1096] a comet appeared in the east in the first week of October [in Oriente primâ Octobris Hebdomadâ]. Lavatherus [Lavather.], from Nauclerus, Gener. 37, p. 153, vol. II [ex Naucler. Gener. 37, pag. 153, tom. II.].

Soon, when the holy war had been taken up [Mox ſuſcepto bello ſacro], a terrible comet was seen at the beginning of October in the western region [in occidentali plagâ], for eight days. Lavatherus, from Stumf. Urspurgens. [Lavath. ex Stumf. Urſpurgenſ.], Palmerius, and Rockenbach [Rockenbachius].

In AD 1097 [A. C. 1097] a star not very bright [Stella non nimis fulgida] appeared, putting out from itself one faintly shining ray [radium unum ſubluſcidum de ſe protendens], like the moon [ut luna]. Calvisius, from the *Histor August.* [Calviſ:ex Hiſtor Auguſt.]. Myzaldus refers a comet in the year 1097 to the sign of Capricorn [ad Signum Capricorni refert], p. 172.

In the year 1097 [Anno 1097] a comet appeared. Urspurg. [Urſpurg:], p. 228. In the year 1097 a comet was seen in the western region [in occidentali plagâ]; Palmerius.

In the year 1097 [Anno 1097], in the 41st year of Henry [Henrici anno 41], a comet appeared in the west, for the whole first week of October [totâ primâ hebdomadâ Octobris]. Sigebertus, Lycosthenes [Sigebert: Lycoſthen.]. Alstedius reports one comet seen in each of the years 1095, 96, 97, 99, 1101, 1106, 1109, 1110, 1112 [annis 1095,96, 97, 99, 1101, 1106, 1109, 1110, 1112 ſingulis, ſingulos Cometas viſos refert].

[Margin: Cometa formam enſis referens.] *A comet resembling the shape of a sword.* In the year 1095 [Anno 1095], on the 7th day of October [die 7 Octobr:], a comet in the shape of a sword [formâ enſis] was observed toward the south

[versùs meridiem]. In this same year a comet was seen again [Eodem hoc anno iterum viſus eſt Cometa]. *Chr. Saxon.*; Eckstorm [Chr. Saxon:Eckſtorm.].

In the year 1097 [Anno 1097], in the month of October [Menſe Octobri], a comet shone in the western region. *Ecclesiastical History*, century 12, chapter 13, from Sigebertus [Hiſt: Eccl: cent: 12, cap: 13 ex Sigeberto]. Büntingus, from Joh. Stumphius [Büntingus ex Joh: Stumfio].

AD 1098 or 1099. [Anno Chriſti 1098 vel 1099.]

[Margin: Cometa inſtar acinacis.] *A comet like a scimitar.* In the year 1099 [Anno 1099], around the Nones of October [circa Nonas Octobres], we saw a comet standing in the southern region [in plagâ meridianâ ſtantem] and stretching its splendour out obliquely, in the manner of a sword [ſuumq́; ſplendorem in obliquum, gladii more protendentem]. Urspurg., p. 231 [Urſpurg: pag: 231]. Lavatherus.

In the year 1098 [Anno 1098], in the 10th year of William II [anno 10 Guillerii I I], a comet lasting 15 days [per 15 dies durans] appeared on the Kalends of October [Calendis Octobr:], reaching with its greater hair toward the east and its lesser toward the south [crinibus majoribus ad orientem, minoribus versùs Auſtrum tendens]. Other stars too followed it, like darts thrown in turn [Hunc & aliæ Stellæ, quaſi jacula ſunt ſecutæ, emisſa invicem]. Rockenbach [Rockenb.]. The Abbot of Stade [Abbas Stadenſis] refers this comet to the year 1096, just as he does the one that Urspurgensis says was seen three years later, on the 6th day before the Kalends of March [quem Urſpurgenſis triennio poſt ad 6 Calend. Martii viſum dicit]; but greater credence seems due to Urspurgensis [ſed major Urſpurgenſi fides habenda videtur], who lived at that time [qui tunc temporis vixit].

In the year 1098 [Anno 1098], the tenth of William II, King of England [Guillerii II Angliæ Regis, decimo], there appeared a comet

[Margin: C[[o/ó]]meta duplici quaſi caudâ.] *A comet with, as it were, a double tail.* on the Kalends of October, for 15 days, sending its greater hair toward the east [majorem crinem mittens ad Orientem] and its lesser toward Euroauster [minorem versùs Euro auſtrum]. Other stars also appeared, as if shooting darts at one another [quaſi jacula inter ſe emittentes]. Lycosthenes.

In the year 1098 [Anno 1098], a star was seen toward the west [versùs occaſum], blazing like a fire [inſtar incendii flagrans]. *Chr. Sax.* The *Ecclesiastical History* [Hiſtor. Eccleſ.], century 11, chapter 13, reports on this star as follows, from Malmesburiensis [ex Malmesburienſi]: a comet seen for 15 days around the Kalends of October [circa Calendas Octobris], which turned its greater part toward the east [Ortui] and its lesser toward Euroauster [Euroauſtro]; and other stars were seen, as if darts had been shot out [quaſi jaculis emisſis]. Eckstorm [Eckſtormius].

In the year 1099 [Anno 1099], in the month of October, a comet blazed in the shape of a sword [figurâ enſis]. Bünting., in the *Chr.* [Bünting. in Chr.]

AD 1101. [Anno Chriſti 1101.]

[Margin: Cometa miræ magnitudinis.] *A comet of wonderful size.* Around AD 1101 [Circa A. C. 1101], among many other prodigies, they affirm that a comet of wonderful size also appeared then, which appeared in the west at once as the Sun was setting [qui in occaſu, cadente Sole ſtatim apparebat]. Lavatherus, from Platina; Wolf. [Lavath. ex Platin. Wolf.]

In the third year after this, however (that is, after the comet seen in the year 1099) [Anno verò poſt hæc (ſcil. Cometam anno 1099 viſum) tertio], we saw another star in the east, changing its place by leaps over a long interval [locum ſuum longo interſtitio ſaltibus mutantem], on the 6th day before the Kalends of March [6 Calend. Martii]. Urspurg., p. 231 [Urſpurg. pag. 231]; Lavatherus. Crüger, p. 67 of the *Uranodromus* [Crügerus pag. 67 Uranodromi], doubts that this star was a comet.

In AD 1101 [A. C. 1101], in the first week of Lent [primâ Quadrageſimæ hebdomade], on the 6th feria [feriâ 6], around evening, an unusual star was seen to shine toward the south and the west, and for the space of 25 days it shone, always at the same hour. A huge beam from the east ran against it [Huic ingens occurrit trabs ex oriente]. *Ecclesiastical History* [Hiſtor: Eccleſ:], century 12, chapter 13, from Bergomensis [ex Bergomenſi]. Eckstorm. Others refer this comet to the year 1106, as can be read a little below.

In AD 1103 [A. C. 1103], a comet blazed out with glowing red flames [flammis rutilantibus]. Sebast. Franck [Sebaſt. Franck.].

AD 1104. [Anno Chriſti 1104.]

In AD 1104 [A.C. 1104], new stars are said to have been seen. Prætorius [Prætor.]. But D. Christiani [D.Chriſt.] seems, by an error, to assign to this year the comet that belongs to the year 1531 [A.1531.].

In the year 1104 [Anno 1104], frequent prodigies terrified people's minds [terruére mentes hominum]. The sky was often seen to burn. The Sun and the Moon were frequently eclipsed beyond the usual [præter ſolitum defecére]. Several stars were seen to fall from the sky to the earth. Burning torches, fiery darts and flying fire were seen rather often to be carried through the air [ſæpius per aëra ferri conſpecta ſunt], and likewise new stars. Lycosthenes.

AD 1106. [Anno Chriſti 1106.]

In AD 1106 [A.C.1106], from the first week of Lent until the Passion of the Lord [ùsq́ue ad Pasſionem Domini], we saw a comet of immense brightness [Cometam immenſi fulgoris]. Lavatherus, from Urspurg., p. 248 [Lavath. ex Urſpurg. pag. 248.]. [Margin: Cometa igneus.] *A fiery comet.* An unusual star was seen this year in the first week of Lent, on the 6th feria [fer. 6], around evening, shining toward the south and the west, and for 25 days it always shone at the same hour, etc. Not much later a comet appeared, drawing long and flaming hair through the morning [per manè]. Lavatherus, from the *Chronic.*

Norimb. [Lavath: ex Chronic: Norimb:], but refers it to the year 1099; Wolfius, however, refers it to the year 1106.

In AD 1106 [A. C. 1106], in the month of February, two days after the new moon [biduo poſt novilunium], a great comet was seen toward the winter setting of the Sun [ad occaſum Solis brumalem]. Calvisius, from Tyr. [Calviſ: ex Tyr.]

In AD 1106 [A. C. 1106], a comet blazed out for almost the whole of February, and many portents in the sky went before it, etc. [quem multa in cœlo oſtenta præcurrerunt, &c.] Myzaldus, p. 240 [Myzald. p. 240.].

In AD 1107 [A. C. 1107], a comet of black colour [Cometa atri Coloris], together with other signs and prodigies, [Margin: Cometa long[[á/â]] Caudâ.] *A comet with a long tail.* in the east, for 40 days and a little longer [per 40 dies & paullò ampliùs], was seen around nightfall [circa initium noctis], having a long hair [Comam longam habens]. Rockenbach [Rockenb:], from Lycosthenes [ex Lycoſthene]. A very great comet [Cometes maximus] was seen at Shrovetide [tempore carnisprivii]. Funccius [Funcc.]. Prætorius adds that the Emperor Henry IV died in the same year [eodem anno mortuum Imp. Henricum IV], which Calvisius also has.

In AD 1106 [A. C. 1106] a comet appeared, about one cubit distant from the Sun [à Sole diſtans quaſi cubito uno], from the third hour until the ninth hour, sending out a long ray from itself [radium ex ſe longum emittens]. Matthew Paris [Matth. Paris], *Hist. Anglica* [Hiſt. Anglica] under Henry I [ſub Henrico Primo], p. 60. Perhaps it was a tailed parhelion [Fortè fuit Parelius caudatus].

In AD 1106 [A. C. 1106] a comet star [Cometa Stella] was seen. The Appendix to Marianus Scotus [Append. Marian. Scoti].

In AD 1106 [A. C. 1106] a comet appeared for almost the whole month of February. Sigebertus [Sigebert.].

In AD 1106 [A. C. 1106], in the month of February, two days after the new moon [biduo poſt novilunium], a great comet was seen toward the winter setting of the Sun [ad occaſum Solis Brumalem]. Calvisius, from Tyr. [Calviſ. ex Tyr.]

In AD 1106 [A. C. 1106], from the first week of Lent until the Vigil of Palm Sunday [ad Vigilias Palmarum], a horrible comet was observed [conſpectus eſt horribilis Cometa]. In the same year the Emperor Henry IV died [obiit Henricus IV Imperat.]. Eckstorm [Eckſtorm.], from the *Chron. Saxon.* [ex Chron. Saxon.].

In AD 1106 [A. C. 1106] the *Ecclesiastical History* [Hiſtoria Eccleſiaſtica] reports on this comet as follows, from the monk Simeon of Durham [ex Simeone Dunelmenſi Monacho]: In AD 1106 [Anno Domini 1106], on the 14th day before the Kalends of March [14 Calend. Martii], a certain unusual star was shown, and for 25 days it was seen to shine in the same way and at the same hour between the south and the west. [Margin: Cometa obſcurus inſtar Trabis.] *A dim comet, like a beam.* It appeared small and dim [parva viſa eſt, & obſcura], but the brightness that went out from it was very clear; and, like a huge beam,

a brightness from the eastern and northern quarter [de Orientali & Aquilonari parte] thrust itself into the same star. One can also read about this comet what the *Cosmodromium* of Persona [Coſmodromium Perſonæ] has, Age 6, chapter 55 [æt. 6, c. 55.]. Some said that they had seen several unusual stars at the same time. Eckstorm [Eckſtormius].

AD 1108, or 1109. [Anno Chriſti 1108, vel 1109.]

In AD 1109 [A. C. 1109] a comet blazed in the second year of the reign of Henry V [anno ſecundo Imper. Henrici V]. Lavatherus [Lavath:], from Peucerus, *de divinatione*, p. 359 [ex Peucero de divinatione p. 359:]. Eckstorm.

In AD 1109 [A. C. 1109] the sea rose higher than usual [Mare præter morem crevit], a comet was seen for some days, the earth shook, etc. Lavatherus, from Polydor. [Lavath. ex Polydor.]. Note: according to Calvisius, Henry V received the Empire at the beginning of the year 1106 [Imperium accepit anni 1106 initio]; hence the second year of the reign coincides with the year 1107, or 1108,

[Margin: [[c/C]]ometa niger.] *A black comet.* In AD 1107 [A. C. 1107] a black comet was seen for 40 days and more [Ater 40 dies & eò ampliùs Cometa], around nightfall, trailing its hair far [longè comam trahere]. Lycosthenes.

In AD 1107 [A. C. 1107], for forty days and more [Quadraginta dies & eo ampliùs], a black comet was observed around nightfall, which trailed a long hair [qui longam Comam trahebat]. *Ecclesiastical History* [Hiſt. Eccl.], from Tyrius [ex Tyrio], book 11, chapter 5.

In AD 1108 [A. C. 1108], in the reign of Henry I, King of England [Henrico primo Angliæ Rege imperante], a comet appeared in Nordmannia [in Nordmanniâ] for some days. Lycosthenes.

AD 1110. [Anno Chriſti 1110.]

[Margin: Cometa per totos ſex Menſes viſus.] *A comet seen for six whole months.* In AD 1110 [A. C. 1110], when Henry V wished to receive the blessing at Rome [Romæ benedictionem recipere voluit] and had already made himself ready for the journey [ſeq́; jam itineri accinxit], a comet terrified him; it appeared for six months. Lavatherus, from Urspurg. and Nauclerus [Lavath. ex Urſpurg. & Naucler.], vol. 2, Gener. 38, p. 182.

In AD 1110 [A. C. 1110.] a comet appeared on June 6 [die 6 Junii], which threw its tail toward the south [qui Caudam versùs Auſtrum projecit]. Calvisius, from Tyr. [Calviſ. ex Tyr.] Myzaldus (who says in the month of July) [Myzald. (qui dicit Menſe Julio)]. Rockenbach. Wolfius, century 12 [Centur. XII], from Sigebertus [ex Sigebert.].

In AD 1110 [A. C. 1110] a comet appeared in an unusual manner [more inſolito]. For when rising from the east [ab oriente ſurgens], it had ascended into the firmament, it seemed not to go forward but to go back [non progredi, ſed regredi videbatur]. Matthew Paris, *Hist. Angliæ* [Hiſt. Angliæ], p. 62.

In AD 1110 [A. C. 1110], in the month of June, a comet appeared, directing its rays toward the south [radios dirigens ad Auſtrum]. Sigebertus [Sigebert.]; Lycosthenes [Lycoſthen.]; Eckstorm [Eckſtorm.], from the *Ecclesiastical History* [ex Hiſtor. Eccleſ.].

In AD 1111 [A. C. 1111] a comet shone for a long time, and it was judged to threaten Italy [judicatus eſt minitari Italiæ]. Phil. Mel. [Phil.Mel.], *Chron.* book 4, under the Emperor Henry V [in Henrico V Imp.]. Simeon of Durham [Simeon Dunelmenſis] also mentions an earthquake and a comet under this year [Terræ motus & Cometæ ſub hoc anno meminit etiam], as the *Ecclesiastical History* [Hiſt.Eccleſ.] reports, century 12, chapter 13.

AD 1113. [Anno Chriſti 1113.]

[Margin: Ingens Cometa.] *A huge comet.* In AD 1113 [A. C. 1113], in the month of May, a huge comet appeared [Cometa ingens apparuit]. Matthew Paris, p. 63.

AD 1132. [Anno Chriſti 1132.]

In AD 1132 [A. C. 1132] a comet of dreadful size was seen [Cometa horrendæ magnitudinis viſus eſt]. Eckstorm, from Bünting [ex Büntingo] and the *Ecclesiastical History* [Hiſt. Eccl.], century 12, chapter 13.

Alstedius assigns a comet to AD 1132 [A. C. 1132, Cometam aſſignat Alſtedius.].

In AD 1133 [A. C. 1133], on the Ides of October [Idus Octobr.], a star of a comet appears [Stella Cometæ apparet]; at this [unde] the King of England, those about the King's side [latusq́; Regium ambientes], and very many others [alii quàm plures], marvelling and raising their eyes to heaven, saw the Sun shine like a new moon [Solem adinſtar novæ Lunæ lucere conſpexerunt]. The Sun, however, did not keep one state for long [qui tamen non diu ſe uno modo habebat]. For it seemed sometimes broader, sometimes thinner, at times more upright, now firm in its usual way, now moving, and, in the manner of quicksilver, moved and fluid [ad modum vivi argenti motus & liquidus]. Eckstorm, from the *Ecclesiastical History*, century 12, chapter 13, and from the Prior of Hexham [ex Priore Hauguſtaldenſi].

AD 1141. [Anno Chriſti 1141.]

In AD 1141 [A.C. 1141] such flames were also seen [Viſæ ſunt etiam tales flammæ]. Prætorius [Prætor]. In AD 1141 [A. C. 1141] frequent portents were seen in the sky at this time, comets too were observed [nec non Cometæ conſpecti], and the sky burned [cœlumq́; arſit]. Lycosthenes.

AD 1145. [Anno Chriſti 1145.]

In AD 1145 [A. C. 1145] a comet appeared in May. The Appendix to Marianus Scotus [Append. Mar. Scoti], chapter 473; Eckstorm, from the *Ecclesiastical History* [Hiſt. Eccleſ.].

AD 1146. [Anno Chriſti 1146.]

In AD 1146 [A. C. 1146] a comet appeared in the west for many days, lighting up the neighbouring air for a month [illuminans in menſem] with flashing rays spread out over the spaces all around [ſpatiis circumquoque diffuſis, coruſcantibus radiis]. Paris, *Hist. Anglic.* [Hiſt. Anglic.], p. 77. Whether these comets were entirely different I cannot affirm for certain, since the authors disagree greatly among themselves [Cum Autores inter ſe valdè ſint diſcrepantes].

[Margin: Duo Cometæ ſimul viſi ſunt.] *Two comets were seen together.* In AD 1165 [A. C. 1165] two comets appeared together before sunrise, one of which was toward the south, the other toward the north [ad Aquilonem]. Calvisius, from Roger. Arra. [Calviſ. ex Roger. Arra.] As Malcolm's fatal day drew near, etc. [Inſtante Malcolmi die fatali &c:]: fourteen days before the King departed from life [antequam Rex è vitâ diſcederet], a comet was seen to burn with two very long rays. Malcolm, however, died [Extinctus eſt autem Malcolmus] in the year 1165 of the Incarnation of Christ [Anno Incarnationis Chriſti 1165.]. Hector Boëtius [Hect. Boëtius], *Histor. Scot.* [Hiſtor. Scot.] book 13, fol. 270. Riccioli [Ricciolus], from Cardanus [ex Cardano], refers this comet to AD 1169 [A.C. 1169.].

In AD 1165 [A. C. 1165] a comet was seen in the sign of Libra [in Signo Libræ], notes Eckstorm, from Herlicius [ex Herlic.].

AD 1168. [Anno Chriſti 1168.]

[Margin: Num hæ Stellæ genuinæ fuerint Cometæ, valdè dubito.] *I very much doubt whether these stars were genuine comets.* In AD 1168 [A. C. 1168], on the vigil of the Lord's Nativity [in vigilia Natalis Domini], two stars of a fiery colour appeared in the west, one of which was large, the other small; they were, as it were, joined [erant quaſi conjunctæ], afterwards they were separated, and after a long interval [longo ſpatio] they ceased to appear. Sigebertus. Lycosthenes. I doubt whether these stars were comets.

[Margin: Etiam hunc Cometam inter uſpectos refero.] [recte: ſuſpectos] *I also count this comet among the suspect ones.* Around AD 1175 [A. C. 1175 circiter], a portent appeared in the sky. A huge star [Sidus immenſum], with very many stars around it shining a little more reddish [paulò rubicundiùs fulgentibus], stood fixed in the west continually, night and day [noctemq́; diemq́; perpetuò in occidentem fixum tenuit]. Hector Boëtius [Hector Boëthius], book 13, fol. 272.

In AD 1180 [A. C. 1180] Alexius Connenus the Younger [Alexius Connenus Junior] obtained the Empire of the East, etc.; at that time a comet was observed in the sky. Eckstorm [Eckſtorm.], from Choniates [ex Choniata], in the reign of Alexius [in Imperio Alexii].

AD 1200. [Anno Chriſti 1200.]

[Margin: Cometa triplo Venere major.] *A comet three times larger than Venus.* In AD 1200 [A. C. 1200] Haly Ben Rodoan, an Arab [Arabs], when as a young

man he was devoting himself to astronomy [cùm Juvenis Aſtronomiæ operam daret], saw a comet whose solid part appeared three times larger than Venus [triplo major Venere apparuit], and of round figure; and its light, he says, as great as if a quarter of the Moon were shining [quantum ſi quarta pars Lunæ luceret]; its place in 15° of Scorpio; and it moved with the motion of the first mobile [motu primi mobilis], from east to west, so that it was carried faster against the order of the signs [contra Signorum ordinem], until it reached 15° of Virgo [àd 15° Virginis]. So he himself in book 2 of the *Quadripartitum*, chapter 9 [ita ipſemet in lib. 2 quadripartiti cap. 9], and Cardanus in the same place, text 54 [ibidem textu 54], describing from Haly several astrological circumstances of this comet [plures circumſtantias Aſtrologicas hujus Cometis deſcribens ex Haly].

In AD 1202 [A. C. 1202] a comet appeared in Scorpio, as D. Herlicius asserts.

AD 1211. [Anno Chriſti 1211.]

[Margin: Cometa Borealis.] *A northern comet.* In AD 1211 [A. C. 1211] a comet appeared, lasting eighteen days of May [decem octo diebus Maji durans], wheeling above the Polouzos, the Tanais and Russia [ſupra Polouzos, Tanaim & Ruſſiam gyrans], and stretching its tail toward the west. Matth. de Michov, in the *Corpor. Histor. Polon.* [in corpor. Hiſtor. Polon.], vol. 2 [tom. II], p. 84. Lycosthenes [Lycoſthen.]. But Cromerus, in the same *Corpus Histor.* [in eodem Corpore Hiſtor.], p. 525, says its hair was turned toward the east [Comam in Orientem obverſam dicit]. From there Lavatherus, Funccius, Rockenbach, Prætorius record it [Inde eum recenſet Lavath. Funcc. Rockenbach. Prætor.]; D. Christiani [D. Chriſt.] adds: near the arctic pole, with its hair facing the winter rising [Comâ ſpectante ortum brumalem]. Spondanus [Spondan.], in the *Auctar.* [in Auctar.]. Note: if it was near the pole in the month of May, with the Sun standing in the middle of the sign of Taurus, in the morning its tail faced the winter setting, in the evening the winter rising [manè Cauda occaſum brumalem, veſperi ortum brumalem ſpectavit].

AD 1214. [Anno Chriſti 1214.]

[Margin: Bini Cometæ ſimul viſi.] *Two comets seen together.* In AD 1214 [A. C. 1214] two comets, terrible in aspect [aſpectu terribiles], were seen in the month of March, one of which went before the Sun and the other followed it. Eckstorm, likewise from Hect. Boëtius [pariter ex Hect. Boëtio], book 13; *Chron. Hirsaug.* [Chron. Hirſaug.]. It mentions one [Unius meminit], which appeared on the day before the Nones of March [prid. Non. Martii]. The *Ecclesiastical History* reports it [Refert Hiſtor. Eccleſ.], century 13, chapter 13.

AD 1214 or 1215. [Anno Chriſti 1214 vel 1215.]

In AD 1215 [A. C. 1215] a comet shone, in the month of March. Calvisius [Calviſius], from Richard. [ex Richard.]

In AD 1214 [A. C. 1214], in March, two comets appeared in Scotland [in Scotiâ apparuére]; one going before the Sun and the other following, they were seen. Hector Boëtius, book 13, *Histor. Scot.* [Hiſtor. Scot.], fol. 279; from him Riccioli [hinc Ricciolus].

AD 1217. [Anno Chriſti 1217.]

In AD 1217 [A. C.1217], in autumn, after sunset, a star appeared in the southern part [in Auſtrali parte], gradually declining toward the west, opposite the Crown of Ariadne [ex adverſo Coronæ Ariadnes]. From it a ray was seen to rise, in the manner of a beam, up to the middle of the sky [in cœli medium usque]. And after some days, diminished again, it took back the form of the earlier star [prioris Stellæ formam recepit]. The *Ecclesiastical History* reports it [Refert Hiſt. Eccl.], century 13, chapter 13, from Urspergensis and Schedelius [ex Urſpergenſi & Schedelio]. Eckstorm [Eckſtormius &], and another comet of immense size at the year 1219, which was observed in England [qui in Angliâ obſervatus]; from Polyd. Virgilius [ex Polyd. Virgilio].

AD 1222. [Anno Chriſti 1222.]

[Margin: [[o/O]]bſervatio Cometa in Iſlandia facta.] *An observation of a comet made in Iceland.* In AD 1222 [A. C. 1222] the Sun showed a blood-red colour [Sol ſanguineum repræſentavit colorem], and a comet was seen, and the fourth eruption of fire from Mount Hekla [Montis Heclæ] took place, such as the first was in the year 1104, in which blood was seen to flow from bread [quo viſus eſt ſanguis è pane emanare]. Petrus Resenius [Peder Resen], in the *Edda Islandorum*, on the testimony of Erasmus Bartholin [Teſte Eraſmo Bartholino], p. 88, *De Cometis*.

AD 1223. [Anno Chriſti 1223.]

In AD 1223 [A. C. 1223] a comet terrible to see [viſu terribilis] appeared throughout all France [per totam Franciam]. After it, Valdemar [Waldemarus], King of Denmark, was captured through treachery [per inſidias] by Heinrich, Count of Schwerin [ab Henrico, Comite Suerini]. Rockenbach [Rockenb.]; D. Christiani [D. Chriſt.]. Lycosthenes [Lycoſth.] calls this comet cruel.

In AD 1223 [A. C. 1223], around the Feast of St Peter in Chains [Circa Feſtum S. Petri ad Vincula], Philip, King of the Franks [Philippus Rex Francorum], died [diem clauſit extremum], and his death was signalled [indicavit] by a comet, a burning and haired star [Stella ardens & crinita], which had appeared a little before. Paris, *Histor. Anglic.* [Hiſtor. Anglic.], p. 305. According to Calvisius, Philip died on July 14 of the said year 1223 [die 14 Julii, anni dicti 1223]. A comet, together with certain other prodigies, preceded the death of Philip, King of the Franks. Nauclerus [Naucler.], at the year 1223.

AD 1238, or 1240. [Anno Chriſti 1238, vel 1240.]

[Margin: Cometa borealis per ſex Menſes conſpicuus.] *A northern comet, visible for six months.* In AD 1240 [A. C. 1240], in Saxony [In Saxoniâ], I saw a comet

near the North Pole [juxta Polum Septentrionalem], and it cast its rays between the east and the south, directing them more toward the rising [magis dirigendo eos ad Ortum]. Albert. Magn., book 1 of the *Meteorol.* [l. 1. Meteorol.], tract 3, chapter 5; according to Riccioli [Riciol.], Lavatherus [Lavath.], Rockenbach, Eberus [Eber.], Lycosthenes. Riccioli affirms that this comet was scarcely extinguished within six months, on the testimony of Dan. Sandbeck [teſte Dan. Sandbeck], and that the same comet is referred by Cardanus to the year 1260 [Eundemq́; à Cardano ad annum 1260 referri].

In AD 1240 [A. C. 1240], through the whole month of February, at a late hour [Tempore ſerotino], a certain dark star [quædam fuſca ſtella] appeared toward the west, sending out a ray toward the east; many truthfully asserted that it was a comet [quam eſſe Cometam multi veraciter aſſerebant]. Paris, *Hist. Angl.* [Hiſt.Angl.], p. 506.

In AD 1238 [A. C. 1238] a star of immense size appeared for some days before sunrise; it was carried along a long stretch of the sky [per longum cœli tractum] with a swift and frequent course [veloci crebroq́; curſu], now bearing fire before it, now leaving smoke behind it. Eckstorm [Eckſtorm.], from Polyd. Virgil. [ex Polyd. Virgil.]

[Margin: Stella inſtar Luciferi.] *A star like the Morning Star.* In AD 1239 [A. C. 1239] a very great star like the Morning Star [Stella maxima inſtar Luciferi] appeared like a burning torch [ut facula ardens]; it hurled itself through the regions of the air [per tractus aëreos] like a fiery arrow, leaving fire and smoke. Eckstorm, from the *Ecclesiastical History* [ex Hiſtor. Eccleſ.] and from Balæus [Balæo]. Was this a genuine comet? I indeed have reason to doubt it [eſt ſanè quòd dubitem].

In AD 1240 [A. C. 1240] a comet, also of the kind that we call bearded [quos barbatos dicimus], appeared six months before [ante ſex menſes] in the northern region [in borealem plagam], for three months, wandering not in one place but now in one place, now in another [non uno in loco, ſed alio atque alio divagatus]. *Histor. Byzantin.* [Hiſtor. Byzantin.], of Georgius Areopalita [Georgii Areopalitæ].

In AD 1240 [A. C. 1240] a comet appeared in the east which, stretching its hair as far as the middle of the sky [crines in medium usq́ue cœli extendens], was scarcely extinguished within six months. Daniel Santbech, in his *Problem. Astronom.* [Problem. Aſtronom.], Prop. 19 [Prop. XIX.], p. 61.

AD 1241. [Anno Chriſti 1241.]

In AD 1241 [A. C. 1241], under Henry III, King of England, a comet terrible to see appeared for almost 30 continuous days [per 30 dies ferè continuos] in the month of January. Rockenbach asserts that in the same year Henry set out into Wales against David [contra Davidem in Walliam profectum] and subjected him to himself; and also that the wife of the Emperor Frederick, Henry's sister [Friderici Imperatoris Uxorem, Henrici Sororem], died after a great eclipse of the Sun. Isabella [Iſabellam], the Emperor's consort, in childbirth, had died [in

partu mortuam]; Calvisius reports this, and an eclipse of the Sun on October 6 [ad diem 6 Octobr.], under this year 1241, from the Abbot of Stade [ex Abbate Stadenſi].

In AD 1241 [A. C. 1241], in England under King Henry III [in Anglia ſub Henrico III Rege], a comet of dire aspect [diro aſpectu] appeared in January itself [in ipſo Januario], for 30 days. Lycosthenes [Lycoſth.]; Rockenbach.

In AD 1241 [A. C. 1241] a comet blazed out for 30 days [diebus 30 exarſit] around the beginning of this year. Polydorus, book 16 [Polydorus lib. 16.]; Eckstorm [Eckſtormius].

AD 1245. [Anno Chriſti 1245.]

[Margin: Sine dubio pſeMars fuit.] [recte: ipſe Mars] *Without doubt it was Mars itself.* In AD 1245 [A. C. 1245], around the Ascension of the Lord [Circa Aſcenſionem Domini] (which in Calvisius falls on May 25 [quæ Calviſio incidit d. 25 Maji]), a certain star rose toward the south, as if in Capricorn [quaſi in Capricorno], like the Morning Star [ad inſtar Luciferi]: large, bright, but red. Like one of the planets, it kept a fixed rising and setting each day [certum ſingulis diebus ortum tenuit & occaſum], and because it was red, very many people thought [plurimi autumabant] it was Mars. It was not Jupiter, because Jupiter, plainly seen for about five years [circa quinque annos manifeſtè viſus], was by then wandering around Virgo. Many said that, although they had paid constant attention to the stars, it had never, as far as they remembered, been seen by them before [?], etc. [&c.] But after the day of James [poſt diem Jacobi] the star just mentioned was no longer seen so bright; rather, from day to day it lost its size as much as its brightness. Abb. Stadens., living at that time [Abb. Stadenſ. eo tempore vivens], p. 217, second side [facie ſecundâ].

AD 1254 and 1255. [Anno Chriſti 1254 & 1255.]

In AD 1254 [A. C. 1254] a comet was seen for some months in Germany. Lycosthenes [Lycoſthen.]; Rockenbach [Rockenb.]; D. Christiani [D. Chriſtian.]; Prætorius; Alstedius [Alſtedius].

In AD 1255 [A. C. 1255] a comet of immense size appeared. In England the sea ran out beyond its usual custom [mare præter morem ſolitum excurrit]. Walter [Gualterus], Prelate of York [Antiſtes Eboracenſis], died. Lycosthenes; Rockenbach.

In AD 1255 [A. C. 1255] a comet appeared, and higher places were also often struck by heavenly fire [loca eminentiora crebrò cœleſti igni tacta ſunt]. Eckstorm [Eckſtorm.], from Polydorus [ex Polydoro], book 16. The same Eckstorm puts another comet off to the year 1256 [alium Cometam ad annum 1256 rejicit], according to the *Ecclesiastical History* [Hiſtor. Eccleſ.], cent. 13, chap. 13; *Epitom. Mundi*.

AD 1264. [Anno Chriſti 1264.]

[Margin: Cometa retrogradus per 3 Menſes duravit.] *A retrograde comet lasted for 3 months.* In AD 1264 [A. C. 1264] a comet appeared in the month of August, with a great tail. Rising from the east and sending out its rays with great light as far as the middle of the sky toward the west, it lasted three months, and at that time Pope Urban [Urbanus Pontifex] died at Perugia [Perufii]. Lavatherus [Lavath.], from Nauclerus [ex Naucler.], *gener.* 43, and Antoninus [Antonin.]; Palmerius [Palmer.]; Rockenbach; Bizaras, p. 77.

In AD 1264 [A. C. 1264] Palæologus saw a comet in the month of July, rising in the morning in the sign of Taurus [in Signo Tauri manè orientem]. It had a very long and very broad tail; in its breadth the tail was thinned a little [quoad latitudinem cauda pauliſper attenuata eſt]. Calvisius [Calviſ.], from Niceph. Gregor. Prætorius moves the comet and the death of Urban [Vrbani] to the following year. Myzaldus refers this comet to the year AD 1260 [ad annum Chr. 1260], saying that for six months it spread its hair far and wide from the east as far as the middle of the sky [ab ortu ad medium usque cœlum crines longè latèq; diffudiſſe], and did not cease to be seen until Pope Urban departed from the living [priusquam Urbanus Pontifex è vivis deceſſerit]; p. 189. Wolfius: in AD 1263 [Ann. D. 1263] a new star appeared in the sky, of remarkable size, lasting more than three months; rising from the east with great light, it also sent out its rays to the middle of the sky, toward the west. When it first appeared [Quo prius apparente], Pope Urban IV began to fall ill; but on the very same night on which Urban died, it was itself extinguished [ipſe extinctus eſt]. Century 13 [Centuria 13], from

Vincent. [Vin-cent.] O.P. [Ordin. Prædicat.], *Specul. Histor.* [Specul. Hiſtor.], book 31. Note [Nota]: Nauclerus indeed has the same things that Lavatherus reports from him [quæ ex ipſo refert Lavatherus], but under the year 1263.

In AD 1264 [A. C. 1264] a star which the Greeks call a comet [quam Cometen Græci vocant] appeared, of remarkable size, for more than three months [ſuper tres Menſes], and on the very same night on which Urban died, it was extinguished [extincta eſt]. Palmerius; Sifrid., *Epitom.*, book 2 [Sifrid. Epitom. lib. 2.].

[Margin: Cometa per tres Menſes conſpicuus.] *A comet visible for three months.* In AD 1264 [A. C. 1264] a comet of remarkable size shone out toward the east [orientem versùs illuxit], casting its hair [Comam] through the middle of the sky toward the western quarter [ad occiduum cardinem], and it was seen for whole months [per integros Menſes]. Erphordiensis [Erphordienſis]; Bergomensis [Bergomenſis]. Niceph. Gregoras, in book 4 of the *Hist. Rom.* [Hiſt. Rom.], writes this about the comet: When the Emperor Michael [Michaël Imp.] was staying in Thessaly [in Theſſaliâ verſaretur], a portent appeared in the sky, a prophet and forerunner of evils [Vates & prænuncius malorum]: a brilliant comet [Cometes illuſtris], near the sign of Taurus, at night toward dawn [noctu ſub diluculum], a little above the horizon. And as far as the Sun went ahead

[quantum Sol præcedebat], so far did the comet too move away from the horizon day by day [tantùm indies & ille ab horizonte diſcedebat], until at last it passed the very middle of the sky. For when it was first seen, it was the summer solstice, with the Sun passing through Cancer [Soleq́; Crancrum perambulante] [recte: Cancrum]; when it grew faint and was extinguished, the same Sun had completed the autumnal equinox [autumnale æquinoctium confecerat]: three signs had meanwhile been traversed, while the comet stayed fixed around Taurus and gradually faded [Cometa circa Taurum fixo ac paulatim evaneſcente]. So Gregoras [Hæc Gregoras].

In AD 1264 [A. C. 1264] a comet appeared in the east for 40 days around the Kalends of August [circa Calendas Auguſti], two hours before sunrise. At first it was large and bright, with long and broad hair [Comam habens longam & latam], which from day to day began to fail, to join the Sun [Soli adjungi], and to come to nothing [ad nihilum deveniri]. *Annal. Colmar.*

[Margin: Cauda Cometæ citiùs, quàm ipſum caput apparuit.] *The comet's tail appeared sooner than the head itself.* In AD 1264 [A. C. 1264] the star that is called a comet appeared, namely in the east, before daybreak [ante ortum diei], after the morning star [poſt ſtellam matutinam]; that is, it appeared before dawn with many rays: its rays appeared far and wide [longè latèq́;] before the star itself, the comet, rose [antequam oreretur ipſa Stella Cometes]. Then the star itself, the comet, laboured on with a swift course [veloci curſu laboravit], so that it ran ahead [præcurrrerit] [recte: præcurrerit] and went far ahead of the morning star toward the south [longè versùs meridiem præcesſerit Stellam matutinam], that is, of Lucifer [Luciferum]. It was first seen around the feast of St Mary Magdalene [circa feſtum ſanctæ Mariæ Magdalenæ], and it appeared until the octave of St Augustine [usq́ue ad octavum ſancti Auguſtini]. *Compil. Chronol.* [Compil.Chronol.]

In AD 1265 [A. C. 1265] a comet appeared so remarkable that no one who saw it then had seen such a one before [ut nullus tunc videns, viderit talem prius]. For, rising from the east with great brilliance [cum magno fulgore], it drew everything along most brightly [omnia perlucidè pertrahebat] as far as the middle of the hemisphere toward the west, etc. [&c.] And while it lasted for more than three months, Pope Urban [Papa Urbanus] began to fall ill when it first appeared [ipſo prius apparente], and on the same night on which the Pope was dying [qua Papa moriebatur], the comet disappeared. Appendix, Matth. Paris, *Historiæ Anglic.* [Hiſtoriæ Anglic.], p. 967.

AD 1268. [Anno Chriſti 1268.]

[Margin: Cometa[?] admirandæ magnitudinis.] *A comet of admirable size.* In AD 1268 [A. C. 1268] a comet of wondrous size [miræ magnitudinis] was seen around midday [ſub meridiem] (shown, indeed, as a great miracle [magno utiq́ue miraculo oſtenti]) for several days in Scotland, as Cardanus relates in book 2 of the *de Judic.* [Cardan. l. 2. de Judic.]. Riccioli [Ricciol.].

In the twentieth year of Alexander, King of Scotland [Alexandri Regis Scotiæ], which is the year AD 1269 [annus C. 1269], a comet of admirable size [admirandæ magnitudinis] was seen daily around midday [quotidiè ſub meridiem]. Hector Boëtius, book 14, *Histor. Scotic.* [Hiſtor. Scotic.], fol. 291.

In AD 1269 [A. C. 1269], on the sixth day of December, at twilight [crepuſculo], a new and remarkable brightness [novus & inſignis ſplendor], formed into the shape of a cross [in figuram crucis efformatus], lit up from the sky [cœlitus] not only the city but every village around the region [omnem vicum circa regionem]. Lycosthenes [Lycoſthenes].

Around AD 1284. [Anno Chriſti. 1284. circiter.]

In AD 1285 [A. C. 1285] a comet of remarkable size [inſigni magnitudine] appeared. Rockenbach [Rock.]; Lycosthenes [Lycoſth.].

After 19 years, again (that is, from the year 1265 [ab anno ſcil. 1265]), a comet was sighted, as Prætorius has it [habet Prætorius], which will fall around the year 1284 [quod incidet circa annum 1284]. The *Fasciculus temporum* [Faſciculus temporum] reports that comets appeared between the years 1274 and 1284, and likewise between 1284 and 1294; but it seems itself to refer the later one to the year 1302 [ſed poſteriorem referre videtur ipſe ad annum 1302]. For, it says, a comet appeared, and at once the Flemish war follows [ſequitur ſtatim bellum Flandrenſe], in which the flower of the French soldiery fell [ubi cecidit flos militiæ Gallicanæ], in the year 1302.

In AD 1286 [A. C. 1286] a comet appeared which directed its hair toward the west [qui Comam occidentem versùs dirigebat]. *Ecclesiastical History* [Hiſtor. Eccleſ.], from Johannes de Oppido [ex Johanne de Oppido] and the *Fasciculus temporum* [Faſciculo temporum].

AD 1298. [Anno Chriſti 1298.]

In AD 1298 [A.C. 1298] a comet appeared in the sky, a sign of very great slaughter to come [futuræ maximæ cladis indicium]. Lavatherus [Lavath.], from the *Chron. Norimb.* [ex Chron. Norimb.]; Rockenbach [Rockenb.]; Prætorius (who adds: in summer [qui addit in Æſtate]); Spondanus [Spondan.], in the *Auctarium* [in Auctario]; Lycosthenes.

[Margin: Cometa miræ magnitudinis.] *A comet of wondrous size.* In the year AD [Anno C.][693] a comet of wondrous size [miræ magnitudinis] appeared, and a wandering one [& vagus]. Simoneta, book 6, chapter 14 [lib. 6, c. 14.].

In AD 1299 [A. C, 1299] a wonderful comet [Mirabilis Cometa] was seen. On the Kalends of December [Calend. Decembr.] a violent wind overturned buildings. *Ecclesiastical History* [Hiſtor: Eccl:], from Balæus [ex Balæo].

AD 1300. [Anno Chriſti 1300.]

In AD 1300 [A. C. 1300], the year in which the Jubilee was restored by the Pope [Quo anno Jubilæus à Pontifice reductus eſt], a comet was seen. Lavatherus

[693] no year is printed after Anno C.

[Lavath:], from Sebast. Franck. [ex Sebaſt: Franck:]; Rockenbach [Rockenb:]; Wolf., century 13 [Wolf: Centur: 13]; Paul. Lang., *Chronic. Citizense* [Paul: Lang: Chronic: Citizenſe]; Lycosthenes.

In AD 1300 [A. C. 1300] a horrible comet was seen. Eckstorm [Eckſtormius], from Schosserus [ex Schosſero].

AD 1301. [Anno Chriſti 1301.]

[Margin: Cometa in Aquario[?] & Piſcibus.] *A comet in Aquarius and Pisces.* In AD 1301 [A.C. 1301], on the Kalends of December [Calendis Decembris], a comet in Aquarius (according to others, in Pisces [aliis in Piſcibus]), lasting for 15 nights, appeared after sunset, stretching its tail toward the east [Caudam versùs ortum porrigens]. Rockenbach [Rockenb:]; D. Christiani [D. Chriſt:]. Rockenbach adds that the death of Pope Benedict XI [Papæ Benedicti XI] followed; but he died in the year 1304, on July 6 [die 6 Julii]. Hence this comet is perhaps the same as the following one [Undè fortè hic idem Cometa cum ſequente]. Prætorius noted a comet at the year 1301, but not at the year 1300. Likewise Spondanus, in the *Auctarium* [in Auctario]; but Lycosthenes [Lycoſthen.], from Stumfius [ex Stumfio], cites both this one and that one [& hunc & illum citat].

In AD 1301 [A. C. 1301] a comet star [Stella Cometes] was seen, which appeared before the Nativity of the Lord [ante Nativitatem Domini], after sunset, and set before midnight; it poured out its hair toward the east [Comam fudit ad orientem], and was seen for 15 nights. Sifridus, *Epitom.*, book 2 [Sifridus Epitom: lib. 2.].

[Margin: Cometa ab Oriēte in Aquilonem curſum inſtituit.] *A comet set its course from the east toward the north.* In AD 1301 [A.C. 1301] a comet appeared over all Iceland [in tota Islandiâ], and merchants saw the comet at sea [in æquore] around the feast of Michael [circa feſtum Michaëlis]. It was larger than the other stars, and had its tail stretching downward [Caudam habuit deorſum tendentem]; and it moved with a reversed motion [motusq́; eſt motu inverſo], namely from the east toward the north [ab oriente videlicet in Aquilonem]. In southern Iceland, too, a comet was seen from the onset of winter until midwinter [ab ingreſſu hyemis usq́; ad hyemem dimidiatam]. It also appeared at Bergen in Norway [Bergis in Norwegiâ] before the time of the Bacchanalia [ante tempus Bachanaliorum]; but at Rome before the feast of Easter [ante feſtum Paſchæ]. Petrus Resenius, in the *Edda Islandorum*, on the testimony of Erasmus Bartholin [teſte EraſmoBartholino], p. 88, *De Comet.* [deComet.].

[Margin: Meteoron aliquod ignitū hoc fuisſe autumo,] *I judge this to have been some fiery meteor.* In AD 1303 [A. C. 1303] a comet was seen, like a column of fire falling from the sky [tanquam ignis columna de cœlo cadens] and rising again in a moment [in momento reaſcendens]. Lavatherus [Lavather:]. I do not know from which author he drew this phenomenon [Neſcio ex quonam Autore hocce phænomenum deprompſerit]. I certainly very much doubt that it was a genuine comet [Egò profectò valdè dubito, genuinum fuisſe Cometam].

AD 1304. [Anno Chriſti 1304.]

In AD 1304 [A.C. 1304] a comet appeared toward the north for three months [tribus Menſibus versùs Septentrionem]. Lavatherus [Lavath:], from Seb. Franck. [ex Seb: Franck:]; Rockenbach [Rockenb:]; D. Christiani [D. Chriſt:]; Lycosthenes.

AD 1305. [Anno Chriſti 1305.]

In AD 1305 [A. C. 1305] a comet appeared in the Week of the Passion of Christ [in Hebdomade Paſſionis Chriſti]. Funccius [Funcc:], from the *Chron. Saxon.* [ex Chron. Saxon:]; Lavatherus [Lavath:]; Rockenbach [Rockenb:]; Prætorius; Lycosthenes.

In AD 1305 [A. C. 1305] a comet of dreadful size [horrendæ magnitudinis] was seen around the Easter holidays [circa ferias Paſchatis]. Büntingus, from the *Chronico Saxon.* [ex Chronico Saxon:]; Eckstorm [Eckſtormius].

In AD 1307 [A. C. 1307] Lavatherus reports, from someone obscure [ex obſcuro quodam], that a comet appeared. Lycosthenes [Lycoſth:] has many prodigies at this year, but no comet [Cometam tamen nullū].

AD 1312. [Anno Chriſti 1312.]

In AD 1312 [A. C. 1312] a comet appeared for 14 days. Funccius [Funcc.]. Prætorius, Lavatherus; but he carries it forward to the following year [ſed ipſum in annum ſequentem producit]. And likewise Lycosthenes [Itidemq́; Lycoſthenes]. In the *Summa Anglicana* we read [In ſumma Anglicana legimus] that a comet shone this year and departed from the north toward the south, following the motion of Mars [juxta motum Martis]. Lavatherus [Lavath.], from Milichius [ex Milichio].

In AD 1312 [A. C. 1312] a comet of dreadful size appeared for 14 days. Büntingus, from the *Chron. Saxon.* [ex Chron. Saxon.].

AD 1313. [Anno Chriſti 1313.]

In AD 1313 [A. C. 1313] a comet was seen departing from the north toward the south, following the motion of Mars. Prætorius [Prætor.]; Milichius [Milich.], in Lavatherus [apud Lavather.]; Herlicius.

[Margin: Vnus idem ferè Cometa cum priore videtur eſſe[[./,]]] *This seems to be very nearly one and the same comet as the previous one.* In AD 1313 [A. C. 1313] a comet appeared for 14 days, which departed from the north toward the south, following the motion of Mars. Lycosthenes. Hence it seems to be a single comet that is assigned to these two years [Unde unus Cometa videtur, qui duobus hisce annis aſſignatur].

AD 1314. [Anno Chriſti 1314.]

[Margin: Per integros tres Menſes apparuit.] *It appeared for three whole months.* In AD 1314 [A. C. 1314] three moons appeared in the sky [Tres lunæ apparuerunt in cœlo]; and a brightness [fulgor], which they call a comet, appeared toward

the north [Aquilonem versùs], at about the end of Virgo [quaſi ad finem Virginis], for three months. In the same year Philip, King of France [Rex Franciæ Philippus], died. Rockenbach [Rockenb:]; Lavatherus [Lavath:], from the *Chron. Norimberg.* [ex Chron. Norimberg.]. From Palmerius [Ex Palmer.], who relates that in the same year there was a dispute over the election of an Emperor [de Imperatore deligendo contentionem]. From Antoninus [Ex Antonino], but he states that it lasted only six weeks [tantum ſex Septimanas]. Wolf., from Camerar., vol. 2, p. 315 [Wolf. ex Camerar. Tom. ſec. pag 315.]. The one that appeared in the year 1314, at the end of Virgo, is said to have directed its flame toward the north and to have been seen for three weeks (perhaps months) [tres Septimanas (fortè Menſes)]. Prætorius.

In AD 1314 [A. C. 1314] a brightness, which they call a comet, blazed out for three months [tribus Menſibus emicuit]. Palmerius; Lycosthenes.

In AD 1314 [A. C. 1314] a comet appeared toward the north, and at about the end of the sign of the zodiac called Virgo [quaſi in fine Signi Zodiaci, quod diciturVirgo], and it lasted for 6 weeks [per 6 hebdomadas]. *Chron. Citizense* [Chron.Citizenſe.].

In AD 1314 [A. C. 1314] a comet appeared toward the north, and it lasted for six weeks [per ſex hebdomadas]. Nauclerus.

In AD 1314 [A. C. 1314], in the month of October [Menſe Octobr.], a comet of horrible aspect [horribili ſpecie] burned for three continuous months. In the month of December Philip the Fair, King of the Franks [Philippus Pulcher Rex Francorum], died. Peucerus, in the *Divinat*., in the section on meteorology [in Divinat. loco de Meteorologiâ]; Eckstorm [Eckſtormius].

AD 1315. [Anno Chriſti 1315.]

[Margin: Hunc Cometam in Orbe extitisſe Martis referunt.] *They report that this comet stood in the orb of Mars.* In AD 1315 [A.C. 1315] a terrible comet saddened the sky through December [cœlum contriſtavit per Decembrem], and there followed a very great mortality of men and beasts of burden [maxima Hominum Jumentorumq́; mortalitas]. Lavatherus [Lavath.], from Cranzius, *Metropol*., book 9, chapter 2 [ex Cranzii Metropol. l.9, cap. 2.], and Antoninus [& Antonin.].

In AD 1313 [A. C. 1313] a comet appeared in Cancer, as D. Herlicius noted; but from which author, I find nowhere [ſed ex quonam Autore, nuſquam invenio]. For this year Hájek [Thaddæus Hagecius] also reports two others, in his *Dialexis* on the New Star [in ſuâ Dialexi de novâ Stellâ], p. 56. For he says: Two comets also shone in the year 1315, from the month of December until February of the following year; one is said to have been in conjunction with Mars [Marti dicitur fuisſe conjunctus], the other to have stood within the Arctic circle. Both were described by a certain man of Cologne [à quodam Colonienſi], as appears, a copy of whose work, written in his own hand, I have seen and read [cujus manu ſcriptum exemplum vidi & legi]. Using the same arguments that I used, and above all from the parallax and the equal distance

[à Parallaxi & æquali diſtantiâ], he proves that both are to be referred to the sphere of Mars, etc.

AD 1337. [Anno Chriſti 1337.]

[Margin: Bini Cometæ ſimul conſpecti ſunt.] *Two comets were seen at the same time.* In AD 1337 [A. C. 1337] two comets are recorded to have arisen [Cometæ bini ſcribuntur exorti], one of which preceded the other by about the space of one month [ferè unius Menſis ſpatio]. Calvisius [Calviſ.], from Spang. [ex Spang.].

In AD 1337 [A. C. 1337] a comet appeared for four months, and before it was extinguished, another blazed out for two months [emicuit alter Menſibus duobus]. Palmerius [Palmer.]; Lavatherus [Lavath.]; Funccius [Funcc.]; *Chronic. Citizense* [Chronic. Citizenſe.].

[Margin: Alter quatuor, alter duobus Menſibus fulſit.] *One shone for four months, the other for two.* In AD 1337 [A. C. 1337] a comet appeared for 4 months; another joined it [cui alius accesſit], which shone together with it for two months [qui duobus Menſibus cum hoc effulſit]. Funccius [Funcc.]; Bonfinius, decade 2, book 9 [Dec. II lib. 9.].

In AD 1337 [A. C. 1337] a dire comet [Dirus Cometes] lasted more than 4 months in the sign of Taurus [in Signo Tauri amplius 4. Menſes]; another joined it, which shone together with it for more than three months, June, July and August [Junium, Julium, Auguſtum]. Prætorius [Prætor.]; Rockenbach; Lycosthenes.

In AD 1337 [A. C. 1337], while Louis the Bavarian was still reigning [Adhuc imperante Ludovico Bavaro], a comet blazed for 4 months; before it was yet extinguished [quo nec dum extincto], another blazed out, which lasted two months. Eberus [Eber.].

[Margin: Hujus Cometæ curſus ſatis accuratè deſcriptus.] *The course of this comet is described quite accurately.* In AD 1338 [A. C. 1338] Andronicus the Younger, Emperor of the East [Andronicus Junior Imp. orient.], died. Before his death, when the Sun had almost reached the summer solstice [ad Solſtitum æſtivum] [recte: Solſtitium], in the evening right after sunset, a star began to appear, not a haired star but a bearded one, like a sword [Stella non crinita, ſed barbata gladio ſimilis]. It took its rise from the feet of Pegasus [Ortum à pedibus Pegaſi ducebat], which are not far from the Spine of Taurus [à Spinâ Tauri]. Its coma extended widely toward the east; it rose straight toward the north every day by about 3° [rectâ quotidiè versùs Septentrionem aſcendebat tribus circiter partibus]. When it had passed the Arctic Pole, and after [poſt cum] the Lesser Bear [Urſam minorem] and the coils of the Dragon [ſpiras Draconis], it also touched the right foot of Hercules, and from there it ran through the Crown of Ariadne [Coronam Ariadnes], and afterwards the left hand of Ophiuchus. And because there the zodiac [Signifer circulus] is broad, and the equinoctial, and the place is hot [quia ibi latus eſt Signifer circulus & Æquinoctialis & locus calidus], the comet could not last, since its origin consists

in a moist exhalation [humidâ exhalatione]. Therefore, once its coma had been dispersed, it too vanished entirely: for it had indeed the appearance of a star, but was not a star. Niceph. Greg., *Hist. Rom.*, book 11 [Hiſt.Rom.lib.11.].

About AD 1340. [Circa annum Chriſti 1340.]

In AD 1339 [A. C. 1339], two years after (the comet of the year 1337) [Biennio poſt (Cometam anni 1337)], another comet began to be seen. Eberus.

[Margin: Cometa inSigno Virginis.] *A comet in the sign of Virgo.* In AD 1340 [A. C. 1340], three years after (the comet of the year 1337), in the month of March, another shone in the sign of Virgo. Prætorius; Rockenbach; Lavatherus [Lavath.], from Palmerius [ex Palmerio]; Bonfinius [Bonfin.], *Rerum Ungaric.*, decade 11, book 9, p. 324 [decad. 11, lib.9, pag. 324.].

In AD 1341 [A. C. 1341] a comet appears again in Libra, seen near Spica [prope Spicam Virginis]. Advancing nearly 1° each day [ſingulis diebus ſingulis ferè gradibus], it vanished when it had reached Leo. And the Emperor Andronicus dies on June 25 [d. 25 Junii]. Calvisius [Calviſ.], perhaps from the continuator of Nicephorus, Chalcocondylas [fortè ex Nicephori Continuatore Chalcocondyla]. In AD 1340 [A. C. 1340] a comet was seen in the sky. Palmerius; Lycosthenes.

[Margin: Cometa in formâ enſis.] *A comet in the form of a sword.* In AD 1340 [A. C. 1340], as winter was ending and the Sun had entered Aries [Hyeme finiente, & Sole in Arietem ingreſſo], a comet appeared in the form of a sword [in formâ enſis], not unlike the one that had been seen three years before, except that its place and motion differed. It began here at the end of Libra, where Spica [Spica Virginis] then stood, and advanced 5° each hour [ſingulis horis progrediebatur 5 gradibus], until it came into the sign of Leo; and then it vanished. In the same year Edward, King of England [Rex Angliæ Edvardus], defeated the French in battle on June 24 [24 Junii], and either captured or broke up their ships [naves eorum aut cœpit, aut fregit]. *Chron. Saxoniæ*; Eckstorm [Eckſtorm.].

AD 1347. [Anno Chriſti 1347.]

In AD 1347 [A. C. 1347], in the last year of the Emperor Louis IV [ultimo anno Ludovic. IV Imperatoris], a haired star [Stella crinita] was seen for two months. Lavatherus [Lavath.], from the *Chron. Norimb.* [ex Chron. Norimb.].

[Margin: Cometa in Tauro.] *A comet in Taurus.* In AD 1347 [A. C. 1347], in the month of August, a comet was seen in Taurus for two months. Others, again, assert that it was seen for a few days [paucos dies eum conſpectum eſſe]. Prætorius. Riccioli [Ricciolus] reports from Tiornovellus [ex Tiornovello] that in the year 1347, in the month of August, a huge comet was seen in the sign of Taurus, toward the north, and likewise a fiery vapour, as if falling from the sky [de cœlo velut cadentem], to the great terror of those who saw it; but the latter [hunc] was seen for a few days, the former [illum] for two months. Heinrich Eckstorm [Henricus Eckſtormius] asserts that this comet

was observed in the year 1345, from Onuphrius [ex Onuphrio] and the *Chron. Saxon.* [Chron.Saxon.].

AD 1351. [Anno Chriſti 1351.]

In AD 1351 [A. C. 1351] (others put the year as 1352 [alii 1352 annum ponunt]: for perhaps it was still being seen as this year began [fortè enim hoc incipiente adhuc viſus eſt], unless the noting of the time varies for some other reason) a comet appeared in the north [ſub Septentrione], in the month of December. As soon as it was extinguished, violent surges of winds followed [graves ventorum æſtus ſecuti ſunt]; and a heavenly beam [cœleſtis trabs], its forward part burning [priore ardente parte], was seen to glide through the sky. Lavatherus [Lavather], from Palmerius, Aug. Niphus and the *Chron. Norimb.* [ex Palmer. Aug. Niph. & Chron. Norimb.]; Rockenbach [Rockenb.]. Prætorius [Prætor.] refers it to the year 1352.

In AD 1351 [A. C. 1351] a portent of fire [Portentum ignis] was seen in the sky, which the philosophers call a round candle [candela rotunda]. *Fascicul. Tempor.* [Faſcicul. Tempor.].

In AD 1352 [A. C. 1352] a comet appeared directly under the north [ſub ipſo Septentrione], in the month of December. Palmerius [Palmer.]; Lycosthenes [Lycoſthen.].

In AD 1352 [A. C. 1352], in the month of September, a comet appeared toward the north, and violent winds and a great drought followed it [quem ſequuti ſunt venti vehementes & magna ſiccitas]. Schosserus [Schoſerus], from the *Chron. Saxon.* [exChron. Saxon.]; Eckstorm [Eckſtormius].

AD 1353. [Anno Chriſti 1353.]

In AD 1353 [A. C. 1353] Prætorius assigns a comet [Cometam aſſignat Prætorius], and from him [& hinc] Riccioli [Ricciol.], Alstedius.

AD 1362 or 1363. [Anno Chriſti 1362 vel 1363.]

[Margin: Cometa peruox.] *A comet* peruox. In AD 1362 [A. C. 1362], in the year already mentioned [Anno præfato], on the 11th day of March, for several days after [11 die Martii poſt pluribus diebus], a comet appeared at the end of Aquarius near Venus, turning its tail back in Pisces, toward the east, into the place of Mercury [caudam in Piſcibus, versùs orientem in locum Mercurii retorquens]. It lasted up to five weeks [ad quinque Hebdomadas]. *Histor. Polon.*, vol. 11, p. 167 [Hiſtor. Polon. Tom. 11. pag. 167.]. Note: the comet of the year 1264 is described in almost the same words. Perhaps this one is the same as that, set in a different place through an error in the years [per errorem annorum diverſus poſitus]. Note on Michovius's description [De Michovii Deſcriptione nota]: on the 11th day of March [Die 11 Martii] the Sun was at about the beginning of Aries; hence the comet, which is said to have directed its tail toward the east, must have been at the end of Aquarius with a great northern latitude [cum latitudine Boreâ magnâ], namely near the upper wing

of Cygnus [alam ſuperiorem Cygni]; so in the evening, as soon as it could be seen [ſic veſperi, ſimul ac potuit videri]. The tail was directed toward the rising [in ortum]. In place of Mercury something else should perhaps have been written [Pro loco Mercurii fortè aliud erat ſcribendum].

[Margin: Cometa ad 90 circ. grad. projecit caudam.] *The comet threw out its tail to about 90°.* In AD 1362 [A. C. 1362], in the month of March [Menſe Martio], a comet appeared, stretching its tail toward the east [Caudam ſuam versùs ortum protendens]. Schosserus [Schosſerus], from the *Chron. Sax.* [ex Chron. Sax.]; Eckstorm [Eckſtormius]. Rockenbach [Rockenb.] adds that with its terrible blaze and flame [terribili ſuo ardore & flammâ] it occupied nearly half the sky, scattering its rays toward the west [ſpargendo radios versùs occaſum]. But he puts this comet back to the year 1353 [in annum 1353 rejicit].

In AD 1363 [A. C. 1363] a comet [Cometes] of remarkable size appeared for three continuous months, rising from the east, with a dire burning of the air [diro incendio aëris], casting its rays to the middle of the sky, toward the west [ad medium cœli, versùs occidentem radios ſuos projiciens]. Prætorius. Rockenbach, who adds that Pope Innocent VI [Innocentium VI Papam] and John, King of France [Johannem Regem Galliæ], died in this year. According to Calvisius [Juxta Calviſ.], however, Innocent dies in AD 1362 [A. C. 1362], and John, King of France [Johann. Rex Gall.], in the year 1364 [ann. 1364].

AD 1375. [Anno Chriſti 1375.]

In AD 1375 [A. C. 1375] a comet was seen. There followed a very great sedition at Kraków [Seditio Cracoviæ maxima], and a war in Thuringia, in which Erfurt [Erfordia] was besieged. Rockenbach [Rockenb.]. Calvisius [Calviſius] reports the siege of Erfurt in the year 1374, but says that the war lasted two years.

In AD 1375 [A. C. 1375] the sky was seen to blaze frequently through the whole night [Cœlum totâ nocte crebrò ardere viſum]. A haired star shone forth [Sydus crinitum effulſit]. The Emperor Charles IV [Carolus IV, Imper.] died. Lycosthenes.

In AD 1375 [A. C. 1375], after the haired star, there followed the death of Charles IV [Caroli I V.]. Riccioli [Ricciol.], from Prætorius [ex Prætorio], who has: In the twelfth year after (1363) a haired star shone [duodecimo anno poſt (1363) ſydus crinitum fulſit]. There followed the death of Charles IV. And according to Calvisius [juxta Calviſ.], Charles IV dies in the year 1378 [ann. 1378].

AD 1380. [Anno Chriſti 1380.]

[Margin: Cometa per trrs menſes fuit conſpicum.] [recte: tres] [recte: conſpicuum] *The comet was visible for three months.* In AD 1380 [A. C. 1380] a comet appeared in Aquarius for three whole months [per tres Menſes integros]. There followed a sedition in England against the King's councillors [contra Conſiliarios Regis], and likewise a war between the Bishop of Cologne

[Epiſcop. Colonienſ.] and the Count of Cleves [Comitem Clevenſem]. Rockenbach [Rockenb.].

AD 1382. [Anno Chriſti 1382.]

In AD 1382 [A. C. 1382] a comet blazed for 14 days [per dies 14]; there followed the death of two archbishops of Magdeburg [duorum Archiepiſcoporum Magdeburgenſium], and of the Count of Mansfeld [Comitis Mansfeldici]. Rockenbach [Rockenb.].

In AD 1382 [A. C. 1382], a little while before the death of Louis, King of Hungary [Ludovici Regis Ungariæ] (who died on the Ides of September [Idibus Septembribus]), a comet [Cometes] appeared. Bonfinius, decade 2, book 10, p. 352 [decad. 2. lib. 10, pag. 352.].

In AD 1382 [A. C. 1382], around the holidays of Blessed Martin [circa ferias B. Martini], a comet was seen for 14 days. *Chronic. Saxon.*; Eckstorm [Eckſtorm.].

Around AD 1394. [Anno Chriſti 1394. circiter.]

[Margin: Cometa ſingularū.] [recte: ſingularis] *A singular comet.* In AD 1394 [A. C. 1394] a comet appeared which is called the Spit [qui Veru appellatur], quite singular, with its coma and ray raised upward [cum Coma & radio ſurſum erectis] and its head hanging downward. In the west, passing toward the north [In occidente tranſiens versùs Septentrionem]. Lycosthenes reports it at the same year, 1394, in the same words as Lavatherus [iisdem, quibus Lavatherus verbis refert]. The astronomers said that among the other comets that usually appear this one was the worst [peſſimum]. But because it appeared not in the morning but in the evening time [Sed quia non manè, ſed tempore veſpertino apparuit.], etc. Lavatherus, from the *Fasciculus temporum* [ex Faſciculo Temporum]. Prætorius and Rockenbach place this comet, with the image of a spit [hunc Cometam Veru imagine], at the year 1391. But Rockenbach [Rockenbachius] says that in the next year there took place the defeat of Sigismund, King of Hungary, and of the French [Cladem Sigiſmundi Ungariæ Regis & Gallorum], which was inflicted on him by Bajazeth the Turk [à Bajazeth Turca] in the year 1396, according to Calvisius [juxta Calviſium]; Calvisius, however, adds that the Turkish Annals [ab Annalibus Turcicis] refer it to the year 1392.

[Margin: Valde dubito an tot Cometarum Caudæ ſimul apparuerint?] *I very much doubt whether the tails of so many comets appeared at the same time?* In AD 1399 [A. C. 1399] three great fiery tails of comets [tres Caudæ magnæ ignitæ Cometarum] were seen near Eisenach [propè Yſenach]. *Histor. Erphesfordensis de Landgrav. Thuringiæ*, chapter 141 [capit. 141.]. Perhaps they were tails of parhelia, not of comets [Fortè caudæ pareliorum fuerunt non Cometarum].

AD 1400. [Anno Chriſti 1400.]

In AD 1400 [A. C. 1400], in Lent [in Quadrageſimâ], a horrible comet appeared, with a long tail. Various diseases followed, and pustules loathsome even to

lepers [& puſtulæ etiam leproſis abominabiles]. Lavatherus, from *Stumf. annal.* [ex Stumf. annal.]. Prætorius. Lycosthenes.

[Margin: Cometa ardentisſimus.] *A most blazing comet.* In AD 1400 [A.C.1400] (after Henry [Henricus], having captured and killed Edward [capto & occiſo Eduardo], had seized the Kingdom of England, which according to Calvisius [juxta Calviſium] happened in the year 1399), a most blazing comet [ardentisſimus Cometa] appeared in those days from the north, etc. [&c.] R. Ganguinus, book 9, fol. 195 [lib. 9, fol. 195.].

In AD 1400 [A. C. 1400], and in the three that followed [& tribus ſequentibus], comets blazed [arſerunt Cometæ]. Eckstorm [Eckſt.], from Herlicius [ex Herlicio].

AD 1401. [Anno Chriſti 1401.]

In AD 1401 [A. C. 1401] a great comet appeared, when Rupert [Rupertus] set out for Rome to obtain the crown [pro asſequendâ Coronâ]. Lavatherus [Lavath.], from Sebast. Franck, *Compil. Chronolog.* [ex Sebaſt. Franck. Compil. Chronolog.].

[Margin: Cauda inſtar Pavonis.] *A tail like a peacock's.* In AD 1401 [A. C. 1401] a comet dreadful to see [viſu horrendus], with a spread tail like a peacock's [Caudam habens expanſam, ſimilem Pavonis], was seen at the end of February. Rockenbach [Rockenbachius].

In AD 1401 [A. C. 1401] a horrible comet was seen at the end of February. Eckstorm [Eckſtormius], from the *Chronicon Saxonicum* [ex Chronico Saxonico].

[Margin: Horrendus & clarisſimus Cometa.] *A dreadful and very bright comet.* In AD 1401 [A. C. 1401], while the Sun was traversing the dodecatemory of Gemini [Geminorum dodecatemorion], a sign appeared in the sky in the western region, a messenger of evils [Signum in cœlo malorum nuntius]. This comet was bright and clear, unfolding an upright coma [comam erectam explicans] in the appearance of a blazing fire, and beyond four cubits [ſupraq́; quatuor cubitos] it hurled its rays from west to east just like a spear [non ſecus ac haſtam]. When the Sun had sunk below the horizon, it lit up all the bounds of the earth [omnes orbis terræ terminos] with its own rays poured out, and did not allow the other stars to put forth their light, or the air to be darkened by the shadow of night, because its light surpassed the brightness of the others and stretched out, flaming, to the top of the sky [ad cœli verticem] for as long as it stood above the horizon. This portent was seen by the Indians, Chaldeans, Egyptians, Phrygians, Persians, the inhabitants of Asia Minor, Thracians, Huns, Dalmatians, Italians, Spaniards and Germans, and any other nations that dwell on the shores of the Ocean. This glowing and shining, most dreadful portent, which is called Lampadias [qui Lampadias vocatur], lasted until the equinox [usq́ue ad Æquinoctium], when the Sun began to pass through Libra. *Histor. Byzantina* of Ducas, grandson of Michael [Ducæ Michaëlis Nepotis], chapter 16 [cap. 16.]. Johannes Juvenalis Ursinius [Johannes Juvenalis Urſinius] and

Büntingus, in the *Chronologia* [in Chronologiâ], mention this comet, which shone in the year 1401; and the latter [hicq́;] adds that it was seen in the month of February. From the notes of Ismaël Bullialdus [Iſmaëlis Bullialdi] on this passage [ad hunc locum].

AD 1402. [Anno Chriſti 1402.]

[Margin: Cauda erecta ad modum lanceæ.] *A tail raised upright like a lance.* In AD 1402 [A. C. 1402] a comet was seen for many days before Shrovetide [ante Carnisprivium], which [quæ] stretched upward like a lance, with a thickness of three feet [in ſpiſſitudine trium pedum], sometimes more, sometimes less. *Historia Landgrav. Thuring.*

In AD 1402 [A. C. 1402] Tamerlanes died. Before his death a huge comet blazed for some days, with a bright, funereal and elongated tail [lucidâ & funebri oblongâq́; caudâ], toward that region of the sky which inclines toward the wind Corus [quæ in Corum ventum vergit]. Bizaras, book 9, p. 199 [lib. IX, pag. 199.]. Bonfinius, decade III, book 2, p. 383 [dec. III, lib. 2, pag. 383.].

In AD 1402 [A.C. 1402] a comet appeared, exceedingly outstanding [multum excellens], and I remember that I saw it toward the west, soon, with the Sun already sinking [mox inclinato jam Sole], beyond our horizon. In the following year Tamerlanes raged in the East. D. Malliol., *de Nobilitate* [D. Malliol. de Nobilitate], in Lavatherus [apud Lavatherum]. Lycosthenes [Lycoſthen.].

Before Tamyris, or Tamerlanus as he was called [ſive ille Tamerlanus vocatus], King of the Scythians and Parthians, invaded Asia with a countless host [cum innumerabili manu], moving from distant lands, a huge comet was seen at the eastern cardinal point of the sky [in orientis cœli cardine], which was carried toward the rising [qui ortum versùs ferretur], etc. [& c.] Pontanus, in *Aphor. Centesim. Centiloq. Ptolem.*, p. 166 [in Aphor. Centeſim. Centiloq. Ptolem. pag. 166.]. Eberus refers the same comet to the year 1403. According to Calvisius, however, Temir Cham defeated and captured Bajazetes [Bajazeten] in AD 1399 [anno C. 1399]. Hence perhaps all these comets, except the one in the year 1403 that preceded the death of Tamyris, are to be taken as one [pro uno habendi]. Tamyris, also according to Calvisius, dies in the year 1404.

There appeared to us as boys [Apparuit nobis pueris], as we learned from our parents, a huge haired one [ingens crinita] in the eastern angle [in orientali angulo], which was carried toward the rising with no small speed [non parvâ velocitate]; in its time [per cujus tempora] Tamyris, King of the Parthians, invaded and overthrew the whole of Asia. Myzaldus [Myzald.], from Georgios Trapezountios [ex Georg. Trapezuntio], p. 122.

[Margin: Cometa funebri oblongâq́; Caudâ.] *A comet with a funereal and elongated tail.* In AD 1402 [A. C. 1402] a huge comet blazed for some days, with a bright, funereal and elongated tail [lucidâ & funebri oblongâq́; caudâ], toward that part of the sky which inclines toward the wind Corus [quæ in Corum ventum vergit]. Büntingus [Bünting.], from Peucerus [ex Peucero]. Eckstorm [Eckſtormius].

AD 1403. [Anno Chriſti 1403.]

In AD 1403 [A. C. 1403] a comet was seen in the sky. Galeatius, Duke of Milan [Galeatius Mediolanenſ. Dux], and Tamerlanus [Tamerlan.] die [moritur]. Lavatherus, from Palmerius and Paulus Jovius [ex Palmerio & Paulo Jovio]. Rockenbach [Rockenbachius] adds that it was seen in the east [in Oriente viſum]. Prætorius.

In AD 1403 [A. C. 1403] a comet blazed between the east and the north, with its tail stretched out toward the north [caudâ versùs Septentrionem protensâ]. Eckstorm [Eckſtormius].

Alstedius reports that one comet was seen in each of the years 1400, 1401, 1402, 1403 [ſingulis annis 1400, 1401, 1402, 1403 ſingulos Cometas viſos eſſe narrat].

AD 1407, or 1408. [Anno Chriſti 1407, vel 1408.]

In AD 1407 [A. C. 1407], when the Prussians [Pruteni] were defeated by the Poles with great slaughter of their own [magnâ ipſorum clade], a comet was seen; but others place this war later [Sed alii hoc bellum poſterius faciunt]. Prætorius.

In AD 1408 [A. C. 1408] a comet appeared. *Fascicul. Temporum* [Faſcicul. Temporum.], 87.

In AD 1408 [A. C. 1408] there was an eclipse of the Moon, and a comet blazed. Spang., *Chr. Sax.*, chapter 305 [Spang.Chr.Sax.cap.305.].

AD 1432. [Anno Chriſti 1432.]

[Margin: Cometa exi. guæ quantitatis.] *A comet of small size.* In AD 1432 [A. C. 1432], around the Purification of Mary [Circa Purificationem Mariæ], a comet of small size [exiguæ quantitatis] appeared, stretching the tail of its torch toward the north [in Septentrionem Caudam facis ſuæ porrigens]. *Chr. Polon.*, vol. 2, p. 198 [Chr. Polon. Tom. II. pag. 198.]. The *Annales Turcici* of Johannes Leuenclavius [Annales Turcici Johannis Leuenclavii] also mention it.

In AD 1432 [A. C. 1432], on a certain Wednesday [quodam Mercurii die], toward evening, the light of the Sun failed so far [usq; adeò] that darkness covered the earth. In the same year a tailed comet [Cometes etiam caudatus] also appeared.

AD 1433. [Anno Chriſti 1433.]

[Margin: Cometa tres Menſes duravit.] *The comet lasted three months.* In AD 1433 [A. C. 1433] a very great comet [Cometes maximus] appeared for three months. Funccius [Funcc.], from the *Chronicon Polonicum* [ex Chronico Polonico]. Lavatherus.

A notable and bright comet also appeared then (in the year 1433) [Apparuit & tunc (anno 1433)], glowing red from evening to dawn [à veſpera ad auroram rutilans], appearing for about three months [quaſi tribus Menſibus apparens]. *Chronicon Polonicum*, vol. 2, p. 199 [Chronicon Polonicum Tom. II. pag. 199.].

In AD 1434 [A. C. 1434] there was an eclipse of the Sun, and a comet shone. Lavatherus [Lavath.] and *Chron.*

Norimb. and Sebast. Franck [& Sebaſt. Franck.]. Eckstorm [Eckſtorm.]. But Calvisius has the eclipse in the year 1433, on June 17 [die Junii 17], so this comet is without doubt the same one that was seen in the year 1433. Although Prætorius too places the comet under the year 1434 [ad annum 1434 reponat Cometam].

In AD 1433 [A. C. 1433] it happened on the 28th day of the month Schewal [Menſis Schewalis] (of the year 836 of the Hegira [anni 836 Hegiræ]), which was a Wednesday [qui Mercurii dies erat], at hour 22 [hora 22], that the light of the Sun failed for half an hour [ad horam dimidiam]; and in that same year [quo quidem anno] a tailed star also appeared, namely a comet. Leuenklau [Leuenklau.], *Histor. Turcic.*, book 14, p. 508 [lib. 14, pag. 508.].

[Margin: Cometa per tres Menſes apparuit.] *A comet appeared for three months.* In AD 1433 [A. C. 1433], in Poland, a comet that was not faint [non obſcurus] appeared, shining all night [pernox] for more than three months, with its torch turned toward the west [face ad occidentem versâ]. Lycosthenes [Lycoſthen.]. And in that year King Vladislaus [Vladislaus Rex] died.

In AD 1433 [A. C. 1433] a huge comet blazed, after which Philip, Duke of Burgundy [Philippus Dux Burgundiæ], seized Hainaut, Holland, Zeeland [Hennegoiam, Hollandiam,Seelandiam], the Bavarians having been driven out of them [Bavaris inde ejectis]. Eckstorm [Eckſt.].

AD 1435. [Anno Chriſti 1435.]

In AD 1436 [A. C. 1436] James I, King of Scotland [Iacob I. Rex Scotiæ], was killed, on February 21 [d. 21 Febr.]; before his death, in the autumn, a comet appeared. On the testimony of Hector Boëtius [teſte Hector. Boëtio], book 17, near the end [lib. 17 ſub finem].

AD 1439. [Anno Chriſti 1439.]

In AD 1439 [A. C. 1439] a comet appeared in Poland. Funccius [Funcc.]; from him [hinc] Lavatherus [Lavather.]; Rockenbach [Rockenb.], adding that the death of the Emperor Albert [Imperatoris Alberti] followed, which Calvisius records in this very year 1439 [A. hoc ipſo 1439.]. Camerarius too assigns a comet to this year. Lycosthenes [Lycoſth.].

In AD 1439 [A. C. 1439] a comet appeared. In the same year, on the day of Simon and Jude [die Simonis & Judæ], the Emperor Albert II [Albertus II Imper.] died. Amurathes, the Turkish Emperor [Amurathes Turcicus Imper.]. Eckstorm [Eckſtorm.], from Schosserus [ex Schoſſero].

AD 1444. [Anno Chriſti 1444.]

In AD 1444 [A. C. 1444] a comet was seen at the time of the solstice [Solſtitii tempore], which thoroughly terrified the minds of mortals [qui mentes mortalium perterruit]. Prætorius [Prætor.]. Rockenbach [Rockenb.], adding that in

this year, on November 10 [Novemb. 10], the Christians were slaughtered by the Turks at Varna; Calvisius also has this defeat [quam cladem]. Lycosthenes.

In AD 1444 [A. C. 1444] a comet appeared in Leo. In this year, on the day before Martin's [pridiè Martini], Ladislaus, King of Hungary [Ladislaus Hungariæ Rex], having engaged Amurathes, Emperor of the Turks [cum Amurathe Turcarum Imp.], at Varna with a hostile army [hoſtili exercitu congreſſus], is killed in battle, etc. Paulus Jovius. Eckstorm [Eckſtorm.].

AD 1450. [Anno Chriſti 1450.]

[Margin: Cometa inſt[[ar/æ]] Rompheæ.] *A comet like [?] a rhomphaea.* In AD 1450 [A. C. 1450], in summer [Æſtate], a comet began to appear above the horizon every evening [quotquot veſperis], immediately after sunset, in the likeness of a rhomphaea [in Rhompheæ ſimilitudinem]. Passing under the full disc of the Moon [plenum Lunæ orbem ſubiens], it produced an eclipse, according to the usual order and motion of the heavenly lights in their circuit [in orbem luminum cœleſtium]. Certain people, seeing that this comet expressed the appearance of a sword, moved from west to east and approached the Moon, and seeing the darkness of that eclipse [defectionisq́; iſtius tenebras], interpreted the matter in this way, etc. [&c.] Riccioli [Ricciol.], from Georg. Phranza [ex Georg. Phranzæ], *Hist.*, book 5, chapter 21 [l. 5. Hiſt. c. 21.].

In AD 1454 [A. C. 1454] Eckstorm [Eckſtormius] indeed writes that two appeared [duos apparuiſſe]; but I think these should be referred to the year 1456.

AD 1456. [Anno Chriſti 1456.]

[Margin: Bini Cometæ hoc anno conſpecti ſunt.] *Two comets were seen this year.* In AD 1456 [A. C. 1456] two comets appeared, as the *Annales Turcici* and others have it; the later one [Poſterior] was in the month of June, with a tall tail [proceræ caudæ]. Calvisius [Calviſ.]. Spondanus, in *Auctar.* [Spondan. in Auctar.].

In AD 1456 and 1457 [A. C. 1456 & 1457] comets appeared in different parts of the sky, in the month of August, around the seventh hour of the night, in the east, namely the last [ſcil. ultimus], which appeared. Lavatherus [Lavath.], from Antoninus [ex Antonin.]. He likewise adds [addit idem]: Camerarius writes that both [utrumq́ue] shone in the month of June; but Lavatherus seems to confuse comets that are distinct and of different years [diſtinctos diverſorū annorum], namely of the years 56 and 57 [anni ſc. 56 & 57]. It is of this very comet (according to Kepler, in *Physiol. Comet.* [juxta Kepler. in Phyſiol. Comet.]) that Pontanus is to be understood [accipiendus eſt Pontanus], in *Aphor. Ptol.* [in Aphor. Ptol.]: [Margin: Cometa ultra 60 gradus projecit, caudam.] *The comet threw its tail out beyond 60°.* When we were young men [Nobis adoleſcentibus], a remarkable comet also shone for many days toward the east, in the regions of Cancer and Leo, of such length that with the stretch of its coma [Comæ ſuæ tractu] it took up more than two signs of the sky. Pontanus [Pontan.], p. 166 [pag. 166.]. This same comet, however, Eberus

refers, from Pontanus, to the year 1456 [ad annum 1456]: D. Christiani [D. Chriſt.]. Rockenbach [Rockenb.]. Prætorius puts it back to the following year [eum ad ſequentem annum rejicit]. Under the year 1456 [Anno 1456] the Veruntian interpreter [interpres Veruntianus] reports that a star, namely a comet [Stellam ſc. Cometen], arose with a twin tail [cauda gemina], one directed toward the rising Sun [verſus Solem orientem], the other toward the west. But Murates the Dragoman [Murates autem Dragomanus], author of the Hanivaldan Codex [autor Hanivaldani Codicis], translated this from the Histories of the Turks [Turcorum ex Hiſtoriis] so as to say: that in this year two tailed stars [Stellas caudatas] appeared, of which one was seen in the east, the other in the west. Ioh. Leuenclau, *Histor. Turcic.*, book 15, col. 583 [Ioh. Leuenclau Hiſtor. Turcic. lib. 15, Colum. 583.].

In AD 1456 [A. C. 1456], in the month of June, a comet was seen in the 15th degree of Cancer [in Gradu 15 Cancri], in the east, for a month. Palmerius.

[Margin: Duo Cometæ ſimul conſpecti ſunt.] *Two comets were seen at the same time.* In AD 1456 [A. C. 1456] two comets were seen, one toward the rising Sun [versùs orientem Solem], the other toward the setting [alter in occaſum]. *Annal. Turcic.* of Leuenclavius [Annal. Turcic. Levenclavii.].

In AD 1456 [A. C. 1456,] a comet appeared by night through the summer [per æſtatem de nocte], when Mahometes II, Emperor of the Turks [Mahometes II Imp. Turcarum], was besieging Belgrade, etc. [&c.] Jovius [Iovius.]. The *Chron. Sax.* has it thus: in the month of June, after Vitus's [poſt Viti], a comet blazed out in the 45th degree of Cancer [in 45 gradu Cancri], toward the east [versùs ortum], and was seen for a whole month. In this year there also died Iohannes Hunniades, called the thunderbolt terror of the Turks [Turcarum fulmineus terror dictus]. Eckstorm [Eckſtormius].

[Margin: Cometa cum duabus Caudis.] *A comet with two tails.* Under the year of the world 6964, of Christ 1456, indiction 4, May 29 [Ad annum Mundi 6964, Chriſti 1456, Indictione 4, Maji 29], a comet appeared in the sky, which for many days sent out even a stretched-out smoke [vel fumum protenſum emittebat]. From the Chronicle of a certain anonymous author appended to the *Historia Byzantina* of Ducas [Ex Chronico Anonymi cujusdam adjecto Ducæ Hiſtoriæ Byzantinæ]. The *Historia Musalmanica* [Hiſtoria Muſalmanica] reports (Bullialdus, in his notes on that passage [in notis ad illum locum]) that a comet with two tails was seen; they interpret this as two comets seen [binos viſos interpretantur], in the year of the Hegira 860 [anno Hegiræ 860], which began in the year 1455, on December 11, the fifth feria [Decembris 11, feria 5].

AD 1457. [Anno Chriſti 1457.]

In AD 1457 [A. C. 1457] I find recorded another comet, which began to shine in the month of June, at 20° of Pisces [in 20 Grad. Piſcium], of that kind of comets which they call Black [quos Nigros vocant]. Eberus. Rockenbach [Rockenb.].

In AD 1457 [A. C. 1457] a comet which they call black [quem nigrum appellant] was seen in the month of June, in the twentieth degree of Pisces [vigeſimo Gradu Piſcium], for about 30 days, etc. [&c.] Bonfinius, *Rerum Ungar.*, decade 3, book 8, p. 502 [Rerum Ungar. Decad. 3. lib. 8. pag. 502.].

In AD 1457 [A. C. 1457] a comet which they call black was seen in the month of June, at 20° [Grad. 20], for a month. Palmerius [Palmer:]. Lycosthenes [Lycoſth:]. Lavatherus [Lavath:]. Peucerus, Eckstorm [Eckſtormius].

In AD 1458 [A. C. 1458] a comet appeared in the month of July in the sign of Taurus. Rockenbach [Rockenb.]. The war of Casimir [Caſimiri] against the Prussians [adverſus Prutenos] followed.

AD 1460. [Anno Chriſti 1460.]

In AD 1460 [A. C. 1460] a huge comet appeared again. Capistranus [Capiſtranus] foretold from it [inde] the evils of our age [noſtri ſeculi mala]. Prætorius. Rockenbach [Rockenb.], who adds that the death of Charles VII, King of the Franks [Caroli VII, Regis Francorum], followed. Kraków laid waste with fire and sword [Cracoviam igni ferroq; devaſtatam], etc.

According to Calvisius [Iuxta Calviſ.], Charles VII [Carol. VII] died in the year 1461, on July 22 [Iulii 22.]. But Capistranus, according to Calvisius, dies in the year 1456.

In AD 1461 [Anno C. 1461] a comet was seen, as Curæus notes. Eckstorm [Eckſtormius].

In AD 1463 [A. C. 1463], on the day before James II, King of the Scots [Iacobus I I, Scotorum Rex], died [pridiè quàm vita fungeretur], a very bright comet was seen. Hector Boëtius [Hect. Boëtius], book 18, *Hist. Scot.*, fol. 381 [lib. 18, Hiſt. Scot. fol, 381.]. But according to Calvisius, James II [Iacob II] obtained the kingdom as a boy of six in AD 1437 [anno Chriſti 1437], and he reigned for 23 years; therefore he died in the year 1460.

In AD 1467 [A. C. 1467], after Michael's [poſt Michaëlis], a comet appeared far up from the sign of Pisces [longè ſurſum à Signo Piſcium], as if it had risen under the sign of Cancer; but it was seen very rarely, because the weather was rainy at that time; and it sent its coma toward the east. *Compilat. Chronol.* [Compilat: Chronol.]

AD 1472. [Anno Chriſti 1472.]

[Margin: Cometa colore igneo.] *A comet of fiery colour.* At the end of the month of December, in the year 1471, a huge comet was seen for the following 80 days, of a fiery colour, at the beginning of Libra, stretching out a very long tail. Calvisius, from Trithemius [Calviſ: ex Trithemio.].

Two comets were the causes of the evils mentioned before [præfatorum malorum cauſæ]. One, in the autumn of the preceding year (1471), was very large and red, rising before the light of dawn, stretching its tail forward and toward the west, and lasting one month or thereabouts. In my boyhood, going before dawn with my tutor to the school of letters [ad literarum palæſtram], I

often looked at it, not yet knowing the art of the stars; when I had acquired that art [quàm cùm conquiſivi], I judged it to be the comet Mathuca or Miles [Cometam Mathucam aut Militem], of the nature of Mars, moving through the end of the sign of Virgo and of Libra. The other comet appeared in the next, namely [ſcil:] in AD 1472 [anno Chr: 1472], in January, following the Sun after its setting and drawing its tail, fairly long, behind it toward the east; yet compared with the preceding one it was much smaller [reſpectu tamen præcedentis multò minor fuit], and it lasted two months or thereabouts. I know that astronomers call such a one Dominus Astone [Dominum Aſtone], of the nature of Mercury and somewhat of Saturn: first under Aquarius, then under Pisces and Aries, always following the Sun. Matth. de Michov., *Histor. Polon.*, vol. 2, p. 220 [Matth: de Michov: Hiſtor: Polon: Tom: II, pag: 220.].

Note: Michovius seems to take for two comets the same comet that Regiomontanus also observed, and to have observed it only at the beginning, when it showed itself in the morning a little before sunrise, and at the end, when it showed itself immediately after sunset, neglecting the time between, when it was seen in the middle of the night [per noctem medium].

In AD 1472 [A. C. 1472] a comet appeared at the beginning of the year, around the feast of Agnes [circa feſtum Agnetis], glowing red like fire [igni rutilans], with long black hairs [crinibus longis nigriſq;]; it inclined toward the western region. Its body, indeed, was at first around the beginning of Libra; afterward it turned toward the north, and it lasted 80 days. But before this one had dissolved, another appeared, which had a fiery coma; it was seen placed in the sign of Aries, and it stretched its tail toward the eastern region. Lavatherus [Lavath.], from Nauclerus [ex Nauclero] and the *Chronicon Norimberg.* [Chronico Norimberg:]. Lycosthenes.

[Margin: Quot gradus uno die con[[f/f]]ecerit.] *How many degrees it covered [?] in one day.* In these earlier years [Annis his ſuperioribus] another comet was seen, at first with a thin head and a very short coma [tenui primò capite, comâq; admodum brevi]. Soon, having grown to a remarkable size, it began to turn aside from the east toward the north, now with a quick motion, now with a slack one; and, because Mars and Saturn were each moving back [quod Mars Saturnusq; uterque repedabat], it itself, turned away [averſus ipſe], with its coma moving forward [progrediente Comâ], was carried until it reached the Bears themselves [ad ipſos Arctos]. From there, as soon as Saturn and Mars began to proceed in direct course, it turned its path toward the west, with such speed that in one day it traversed up to 30 degrees; and when it reached Aries and Taurus, it ceased to be seen. This one both shone for very many days and, though at first it was seen shorter, grew so much that it occupied fifty degrees and even more. Pontanus, *Centiloq. Aphor. Centes.*, p. 167 [Centiloq. Aphor. Centeſ. pag. 167.].

Prætorius: the comet that Pontanus noted at the year 1471, and that Regiomontanus refers to the following year, 1472. Rockenbach, however, ascribes both this comet, as a single one [hunc Cometam unum], and the capture by

Afonso, King of Portugal [Alfonſus Portugaliæ Rex], of the cities of Tangier [Tingin] and Arzila [Argillam] in Africa to the year 1472; and he also notes another at the year 1475.

A comet appeared at the beginning of the year 1472, around the feast of Agnes. It passed over Cologne [Coloniam] opposite Libra [in oppoſito Libræ], and sent a long tail, of about 30 degrees, toward the west. On the feast of St. Blaise [In Feſto S. Blaſii] it stood in Aries and sent its tail toward the Pleiades, toward the east. It wandered exceedingly [Vaga nimis erat], and was white at times, and fiery [alba quandoq́ue, & flammea]. *Fascicul. Tempor.*

In AD 1472 [A. C. 1472], Riccioli reports from Petrus Surdus [ex Petro Surdo] that two comets appeared: one in the month of January, which Regiomontanus observed, the other in the month of March, in the form of a javelin [formâ jaculi].

Myzaldus reports that the comet seen in the year 1472, before Usonus Cassanus [Uſonus Caſſanus] invaded Asia, was martial [Martium fuisſe], p. 185.

[Margin: Regiomontani Obſervatio Cometæ 1472.] *Regiomontanus's observation of the comet of 1472.* On the Ides of January in the year 1475 [Idibus Januariis Anno 1475] (but wrongly, since this comet appeared in the year 1472, as Myzaldus [Myzald.] himself admits elsewhere, and as has also been confirmed by us in its place) a comet was seen by us under Libra, with the stars of Virgo. Its head was of slow motion until it was near Spica. Now it advanced through the legs of Bootes, toward his left; departing from there, in one natural day it described a portion of a great circle of 40 degrees. [Margin: Locus Curſusq́;.] *Its place and course.* When it was in the middle of Cancer, it was at its greatest distance from the circle of the signs [ab orbe Signòrum], 77 degrees; and it then went between the two poles of the zodiac and of the equinoctial, as far as the space between the feet of Cepheus [ad intermedia pedum Cephei]; then through the breast of Cassiopeia over the belly of Andromeda. Afterward, proceeding along the length of the northern Fish [Piſcis ſeptentrionalis], where its motion slackened greatly, it approached the zodiac, crossing it near the middle of Aries, until its heliacal setting [occaſus Heliacus], together with the stars of Cetus, hid it from us in the last days of February. [Margin: Incesſit ſub Circulo maximo contra ſeriem Signorum.] *It advanced under a great circle against the series of the signs.* By this proper motion of its own it described a portion of a great circle, by which it was carried northward and, with this, against the succession of the signs, from Libra into Aries. At the end and at the beginning it moved slowly; in the middle of its appearance, very swiftly, in one day through almost four signs, from the end of Virgo as far as the beginning of Gemini. And according to the nature to be ascribed to it, it ought to have continued its motion until, having returned again into Libra, it had appeared. And perhaps it did move in this way, since at its setting it was still of great size. Yet because of its configuration relative to the Sun [propter figuram ejus ad Solem], and above all in the northern regions, it could hardly be seen at the end of its appearance [ægrè in fine ſuæ apparitionis videri poterit], except

toward the south in the days of April, if it had kept the regularity of its motion. [Margin: Cauda continuè ad Geminos fuit protenſa.] *The tail was stretched continually toward Gemini.* Its tail, however, being less mobile, kept facing the stars of Gemini continually and circled around them, never deviating from them through the whole time of its appearance [ab eis per totum apparitionis tempus devians]. Therefore, at its first emergence, it stretched its tail toward the west, since those stars of Gemini were reckoned to be there [quoniam illæ Stellæ Geminorum putabantur]. At the end, however, with the comet placed under Aries, it appeared only in the west because of the nearness of the Sun, with its tail stretched toward the east, because in this position the stars of Gemini were placed there [quia in hoc ſitu ſtellæ Geminorum ponebantur]. [Margin: Diverſa Caudæ Directio.] *The differing direction of the tail.* In the middle of the appearance, however, it turned its tail toward the south: the stars of Gemini were there at that time. And it happened then, on one and the same night [nocte eâdem], that immediately after sunset the tail faced the east; as midnight approached, it faced the south; after midnight, however, the west; before sunrise it pointed to the quarter of the north [indicabat Locum Septentrionis]. This difference in the position of the tail arose from the daily motion, which is always in consequence of the prime mobile [ex conſequentia primi mobilis], from east to west. [Margin: Curſus Cometæ.] *The course of the comet.* By its proper motion, however, the end of the tail, although more slowly than the head of the comet, yet always also moved toward the west, describing a parallel against the succession of the signs, from the beginning of Libra as far as the middle of Taurus: going under the feet of Ululans [ſub pedibus Ululantis], through the Great Bear, approaching Perseus, through whom it went, near the Pleiades, to the tail of Aries, almost in the middle of Taurus. From this it is clear that both the head and the tail of the comet went toward the west, and never toward the east, not only by the daily motion but also by its proper motion. Thus far Regiomontanus, through the diligence of Jakob Ziegler [Jacobi Ziegleri], who did not disdain to share with us this account of the comet [hanc de Cometâ Hiſtoriam] together with his conceptions on Genesis [cum ſuis in Geneſin conceptionibus]. Myzaldus, last chapter of book 1 of the *Cometographia* [Myzald.cap. ultim. lib. 1 Cometographiæ.].

But in Eberus's Catalogue [Catalogo Eberiano], beside the comet of the year 1472, Myzaldus writes in the margin: We have described this comet, from Ziegler, in the last chapter of book 1 of our *Cometograph.* [noſtræ Cometograph.]. And in his own Catalogue, at the year 1472, he says: A great comet was seen through the month of January, which Matth. Palmerius Pisanus [Piſanus], in his Chronicle, reports was called Pertica [Perticam], or Ascona [Aſconam]. Although this comet was described a little before by D. Eberus [à D. Ebero] and by us, because notable events had been omitted it will not be irksome to add them here [illos hîc aſcribere non pigebit]. Etc.

[Margin: Myzaldus hunc Cometam modò ad annum 1472, modò ad ann. 1475 refert.] *Myzaldus refers this comet now to the year 1472, now to the year 1475.*

So Myzaldus refers the same comet now to the year 1472, now to 1475. Kepler places the cause of this discrepancy in a slip [ſphalmate] by Ziegler, who wrote 1475 from a manuscript of Regiomontanus that was not read skilfully [non dextrè lecto], whereas Regiomontanus himself without doubt wrote 1472, with the figure two fully formed [Charactere binarii abſoluto]. Kepler, *Hyperaspist.*, book III, no. 6 [Keplerus in Hyperaſpiſt. lib. III, numer. 6.]. The same, in the same place, no. 9 [Idem ibidem num. 9.]. He also proves that it is the same comet that Pontanus described, from a comparison of the descriptions and from the identity of the season of the year: Regiomontanus indeed expresses this as from January 13 [à 13 Ianuar.] to the end of February [ad Finem Februar.], while Pontanus marks both the year and the season by the station of Saturn and Mars, which fell in February in the year 1472. Next, Eberus, in his Catalogue, after he had described the comet of the year 1472 periphrastically from the words of Regiomontanus, and had said that it fell in the 32nd year of the Emperor Frederick III [in annum 32 Imperat Friderici III], hints that it was described by Pontanus in verse in the *Meteor.* and in prose in the *Comment. Centiloquii* [Carmine in Meteor. & Proſa in Comment. Centiloquii].

It should further be noted here in what sense it is said in the account of the observation [in Hiſtoria Obſervationis] that the comet was near Spica. For Kepler clearly proves that at first it was not seen in the southern part of the ecliptic [non conſpectum eſſe in parte Eclipticæ Auſtrali], in *Hyperasp.* [Hyperaſp.]

book III, chap. XVII, no. 17 [lib. III, cap. XVII, num. 17.].

[Margin: Quo ſenſu interpretanda ſint verba Regiomontani ratione Spicæ.] *In what sense the words of Regiomontanus about Spica are to be interpreted.* (1) Because at the beginning it is said to have been with the stars of Virgo, which are all northern except Spica and one of the sixth magnitude. (2) Because at the beginning it is said to have stretched its tail to the heads of Gemini [ad Capita Geminorum], which are very northern; but since the Sun is placed in the ecliptic, the tail of a comet cannot bend toward the northern region unless the head too is placed in the northern part of the ecliptic. (3) That the observer, in a careful and wordy description [in curiosâ & verbosâ deſcri. ptione], would not have omitted this remark: at what place of the sign of Libra the comet crossed the zodiac. Accordingly, Ziegler's words, Until it was near Spica [Donec propinquum eſſet Spicæ], Kepler interprets thus, no. 16: For as long as it was near Spica [Quantisper propinquum eſſet Spicæ]. For at the beginning the comet was near Spica, relative to the rest of its path [reſpectu reliqui ſui itineris], and this for as long as its motion was slow.

In AD 1472 [A.C. 1472.], after the feast of Epiphany [Poſt feſtum Epiphaniæ], a comet of remarkable size and of many rays appeared under the sign of Libra, directing its rays toward the west; and when eight days had passed in this way, it suddenly climbed toward the Arctic pole and the star of Mars [Stellam Martis], as far as the other part of the zodiac, where it then appeared under the sign of Aries, directing its rays toward the east. It was carried round with the zodiac

by the motion of the firmament, under the sign of Aries, remaining for two weeks [manens ad duas hebdomadas]; and then it gradually diminished, so that on St. Valentine's day [in die Sancti Valentini] it was hardly seen. *Compilatio Chronolog.*

[Margin: WaltheriObſervatio.] *Walther's observation.* In AD 1472 [A. C. 1472.], at Nuremberg [Norimbergæ], on January 20 [die 20 Januarii], at hour 10 from noon [horâ 10 à meridie], the comet was seen in a straight line with the fifth of Bootes [cum quintâ Bootis] and the first of the unformed stars [prima informatarum], near the Great Bear [juxta Urſam majorem]; and the distance of the comet from the fifth of Bootes just mentioned was almost one third of the whole interval between the stars mentioned [ſubtripla fermè erat totius dictarum Stellarum intercapedinis]. The tail stretched to near the sixth of Leo [ad ſextum propè Leonis], and ended a little short of it [citraq́; parùm deſiit]. A little below the first unformed star, declining toward the south, 953, 190 [Paulò ſub prima informata ad meridiem declinans 953, 190.]. Distance of the comet from the tail of the Great Bear, 953, 210 [Diſtantia Cometæ à Cauda Urſæ Majoris 953, 210.]. Distance of the comet from the first of those that are not in the figure [quæ non ſunt in forma]. Walther, in *Observat.*, p. 23 [Walther. in Obſervat. pag. 23.].

In AD 1473 [A. C. 1473], from January 17 to the 18th of the following February [die 17 Januar. usq́ue ad diem 18 ſequentis Februarii], a remarkable comet appeared toward the south, which hurled huge fiery torches southward [ingentes igneas faces Auſtrum verſus ejaculabatur], between the pole and the Pleiades. Appendix of Hector Boëtius, fol. 392 [Append.HectorisBoëtii fol.392.].

AD 1477. [Anno Chriſti 1477.]

[Margin: Haud vulgaris Cometæ color.] *A colour of a comet that is not common.* In AD 1477 [A. C. 1477], a comet appeared, blackish with a sky-blue pallor [cæruleo pallore ſubniger], which is ascribed to Saturn. In the same year Charles of Burgundy [Carolus Burgundus] fell in battle at the town of Nancy [ad oppidum Nancejam]. Eberus. Rockenbach [Rockenb.]. Eckstorm [Eckſtorm.]. Büntingus.

Although it is established meanwhile (from the testimony of Camerarius's Pindarus [ex Camerario teſtimonio Pindari ſui], who had heard this in part) that another comet shone around the time of the killing of Charles of Burgundy [ſub cædem Caroli Burgundi]; which Camerarius therefore ascribes to the year 1475, fol. 305 of my copy [fol. 305 mei exemplaris]. The Emperor Charles V [Carolus V Imperator] too sometimes made mention of this comet, as one that had portended death to his maternal grandfather [avo ſuo materno], Charles of Burgundy. This comet, however, Regiomontanus did not live to see [vivendo non fuit asſecutus], since he had been carried off by the plague at Rome in the previous year, 1476, on July 6 [Jul. 6]. Camerarius is therefore mistaken in placing his death among the effects of the comet of that year, 1477. Kepler,

Hyperasp., book III, chap. 17, no. 10 [Kepler. Hyperaſp. Lib. III, cap. 17, num. 10.].

But according to Calvisius and the account of Eberus himself [ipſius Eberi narrationem], Charles fought near Nancy in the year 1477, on January 5 [Januar. 5.]. Hence the comet must have shone, at the least [ad minimùm], toward the end of the preceding year.

Another comet was seen in the fifth year afterward (after the year 1472, namely in the year 1477), blackish with a sky-blue pallor; in that year Charles of Burgundy was slain. Bizaras, p. 336, book XIV [Bizaras pag. 336, lib. XIV.].

[Margin: Cometa inſtar trabis.] *A comet like a beam.* In AD 1479 [A. C. 1479], in Arabia, a comet was seen in the form of a very sharp beam, marked, as it were, with various dots, with a hay-scythe [cum falce fænariâ]. Lycosthenes.

AD 1491. [Anno Chriſti 1491.]

In AD 1491 [A.C. 1491], according to the observations of Regiomontanus (or rather of Walther, which are joined to them), a comet appeared around the beginning of Aries. Myzaldus [Myzald.]. In the following year Pope Innocent VIII [Papa Innocent. VIII] dies.

In AD 1491 [A. C. 1491] a comet and an eclipse of the Sun occurred. About this we find nothing noted by Walther [à Waltero] in his observations, except that it was around the beginning of Aries, with southern latitude. Prætorius.

[Margin: Cometa capite parvo, ſed caudâ prolixâ apparuit.] *The comet appeared with a small head but a long tail.* In AD 1491 [A. C. 1491], at that time, namely around the feast of the Epiphanies [circa feſtum Epiphaniarum], a haired star [ſidus crinitum], which they call a comet, came into view [apparitione emerſit] under the third face of Pisces [ſub tertiâ facie Piſcium]; astrologers named it Dominus Astone. Its head was not large, but its tail was longer, though thin and of little light; it was of the nature of Mercury, and it followed the Sun after its setting, with its tail stretched out behind it toward the east. *Histor. Polon.*, vol. 2, pp. 223 and 237 [Hiſtor. Polon. tom. II, pag. 223 & 237.].

In AD 1491 [A. C. 1491] a comet appeared in springtime around the beginning of Aries, with southern latitude, together with an eclipse of the Sun in 27° of Aries. Rockenbach [Rockenb.].

Note: according to Calvisius the eclipse occurred on May 8 [d. 8 Maji]; but the comet, which the others call an evening comet [Veſpertinus] in this year, could not have been seen toward evening in springtime if it was at the beginning of Aries. It was therefore seen before spring.

In AD 1491 [A. C. 1491] a comet preceded the death of Casimir, King of Poland [Caſimiri Regis Poloniæ]. Eckstorm [Eckſtormius], from the Saxon Chronicle [ex Chron. Saxonico].

In AD 1491 [A. C. 1491], on January 17 [Die 17 Januarii], a comet was seen around the beginning of Aries, with southern latitude, at the hour between the sixth and the seventh [horâ inter ſextam & ſeptimam]. From the observations of Walther, p. 37.

[Margin: Caudam in oppoſitum Solis projecit.] *It threw its tail opposite the Sun.* In AD 1491 [A. C. 1491]: that around the feast of the Epiphanies a comet appeared about the beginning of Aries [ſub initium Arietis], with a head that was not large but a longer tail, and that it followed the setting Sun and stretched its tail out behind it toward the east, the authority is Michovius, in the *Historia Polonica* [in Hiſtoriâ Polonicâ].

In AD 1492 [A. C. 1492] Rockenbach has another comet, which was seen in December, after sunset, for two months, and which the death of Casimir, King of Poland, followed. But Casimir died in the year 1492, in the month of June. It is clear that this is the same comet that Michovius noted under the year 1491.

In AD 1492 [A. C. 1492], after the middle of December, three suns were seen in Poland at midday [in Meridie]. Then a comet appeared for the space of two months after the setting Sun. Lycosthenes.

AD 1500. [Anno Chriſti 1500.]

In AD 1500 [A.C. 1500], in the month of April [MenſeApr.], a comet of dreadful size appeared in the north, under the sign of Capricorn, for 18 days. Rockenbach [Rockenb.]. Prætorius, Funccius [Funcc.]. Lavatherus [Lavath.]. Eberus. D. Christiani [D.Chriſtian.]. Lycosthenes [Lycoſthen.].

[Margin: Cometa per 4 Menſes apparuit.] *A comet appeared for 4 months.* Myzaldus, *Cometographia*, p. 171 [Myzald. Cometograph. pag. 171], refers the comet that shone in the year 1500, in the month of April, to the sign of Sagittarius; but on p. 173 he refers the comet of the year 1500, which shone for four months, to the sign of Aquarius.

Next, in the year 1500, the comet Dominus Astone, the scourge of God's wrath [flagellum iræ Dei], appeared on the fourth weekday [feriâ quartâ], May 20 [die 20 Maji], in the northern part, under the sign of Capricorn, and was noted wheeling over Lithuania, Russia [Rusſiam] and Lesser Poland. Michovius [Michov.], *Histor. Polon.*, vol. 2, p. 242 [Michov. Hiſtor. Polon. tom. II, pag. 242.]. Eckstorm [Eckſtormius].

In AD 1500 [A. C. 1500], on a day of January [Die Januarii], while we were sailing, a certain comet appeared toward Arabia, whose rays were sent out very far [promittebantur plurimùm]; and so the comet appeared continuously for eight or ten days, day and night. Aloysius Cadamustus [Alvise Cadamosto], *Navigat.*, chap. 67 [Aloyſius Cadamuſtus Navigat. cap. 67], in Lavatherus [apud Lavatherum].

AD 1504. [Anno Chriſti 1504.]

In AD 1504 [A. C. 1504], as Joachim Heller [Ioach. Heller] noted and observed, a comet was seen. Myzaldus.

[Margin: Cometa tempore magnarum Conjunctionum.] *A comet at the time of great conjunctions.* In AD 1504 [A. C. 1504] a comet appeared together with conjunctions of the superior planets. Rockenbach [Rockenbachius].

In AD 1504 [A. C. 1504] a synod [Synodus] of the superior planets, which took place in Cancer, brought forth a dreadful comet in the second year after. Myzaldus, *Cometogr.*, book 1, p. 89 [Myzald. Cometogr. lib. 1,p. 89.].

In AD 1504 [A. C. 1504]: Riccioli says that Cardanus ascribes the comet of the year 1506 [Cometam anni 1506 aſcribere].

In AD 1504 [A. C. 1504] a huge comet was seen in the shape of a burning torch, and a great drought followed it. Schosserus, from Gemma [ex Gemmâ]. Eckstorm [Eckſtormius].

AD 1505. [Anno Chriſti 1505.]

In AD 1505 [A. C. 1505], in the year in which that diet of Maximilian [Comitia illa Maximiliani] took place, a comet of unusual size and of unusual shape appeared at Cologne [Coloniæ]. Mutius, *Chronic. German.*, book 30, p. 312 [H. Mutius Chronic. German. l. 30, pag. 312.].

[Margin: Lucidiſſimus Cometa.] *A very bright comet.* In AD 1505 [A. C. 1505], around the feast of Michael [circa feſtum Michaëlis], and around the new moon of November, a great new star [Stella nova] appeared at the fourth hour or about, before daybreak, lasting until the eighth hour of the day, according to the half clock [ſecundùm medium horologium]. It shone over lands and towns beautifully and brightly, as if it were the Moon, yet not nearly so luminously as the Moon. In the end it showed the way, brightly enough, to those walking in the morning; it passed from the south toward roughly the west [quaſi occaſum versùs], having another, smaller star going before it, which in turn had two smaller ones going before it. It disappeared around the Bacchanalia [Bachanalia] of the year 1506. Appendix to the *Fasciculus temporum* [Append. Faſcicul. Tempor.].

AD 1506. [Anno Chriſti 1506.]

[Margin: Bini Cometæ uno anno conſpecti.] *Two comets seen in one year.* In AD 1506 [A. C. 1506] two comets appeared. The first of them was seen from April 11 [April. 11] for five days, and directed its course, in the manner of the planets, from west toward east. The other, in August, showed itself between the northern and the eastern quarter, near the Lesser Bear, in Leo and Virgo. Rockenbach [Rockenb.]. Calvisius refers them to the preceding year.

In AD 1506 [A. C. 1506], in the month of April, a comet was seen, which Wernerus of Nuremberg [Wernerus Norimbergenſ.] described. Lavatherus.

In AD 1506 [A. C. 1506] a comet appeared in the month of August, between the north and the east, under the Great Bear, glowing red [rutilans], and occupying both signs, Leo and Virgo. Lycosthenes.

Note: the Great Bear [Urſa major] stands between the north and the east in the month of August at the morning hour. Hence that planet too [& ille Planeta] was seen in the morning at the place indicated.

In AD 1506 [A. C. 1506], around the Ides of September [circa Idus Septembris], a comet was seen near the Wain [propè plauſtrum], spreading its hair

toward Spain. In the same year Philip, King of the Spains, etc. [Philippus Rex Hiſpaniarum &c.], died in the city of Burgos [in Urbe Burgarum]. Büntingus [Buntingus], from the Calendar of Paulus Eberus [ex Calendario Pauli Eberi].

According to Calvisius, Philip, Archduke of Austria [Philippus Archi - Dux Auſtriæ], dies [moritur] in Spain on September 28 [die 28 Septembris], in the same year.

[Margin: In adverſam Solis partem Cauda fuit projecta.] *The tail was thrown toward the part opposite the Sun.* In AD 1506 [A. C. 1506] a bright comet appeared for some days in the west [in Occid.], before the death of Charles V [ante Caroli V mortem], on the Ides of Sextilis [Id. Sextil.], in the evening [ſub veſp.], under the Hair of Berenice [ſub comâ Berenices]; its tail inclined toward the east [ad Ortum]. It vanished on the Nones of September [Nonar. Septembris]. Jovius, book 9 [Jovius. lib. 9.].

In AD 1506 [A. C.1506] a haired star [Stella crinita] appeared within the Bear [inter Arcton] on the third day before the Ides of April [tertio Idus Aprilis], and it lasted 25 days. Prætorius.

In AD 1506 [A. C. 1506], in the month of August, a comet appeared for very few days [paucis admodum diebus], between the north and the east, under the Lesser Bear, and occupying both the sign of Leo and that of Virgo [utrumque tàm Leonis, quàm Virginis Signum]. Appendix to Nauclerus, p. 544 [Append. Naucler. p. 544], and from there Lavatherus [hinc Lavath.].

[Margin: Coma Cometæ inſtar caudæ Pavonis.] *The comet's hair like a peacock's tail.* In AD 1506 [A. C. 1506], shortly before Philip, King of the Spains, father of the Emperor Charles [Imperatoris Caroli Pater], died, a comet shone in the north, near the Wain, trailing a splendid and dense tail, which it spread between the front and the rear wheels [inter priores & poſteriores rotas]; and therefore it was called by our people the Peacock's Tail [Cauda Pavonis]. Eberus, *Chron. Citizens.* [Chron. Citizenſ.].

In AD 1506 [A. C. 1506], a little before (the death of Philip of Austria [mortem Philippi Auſtriaci]), a comet had blazed [Arſerat] around the Ides of September, in the north near the Wain, of a hideous and bright appearance [tetrâ lucidâq; ſpecie], with a splendid and dense tail, from which it is called the Peacock's Tail; the tail was thrown toward the wind Corus [in Corum Ventum projecta]. Bizaras, book 17, p. 414 [Bizar. lib. 17, p. 414.].

In AD 1506 [A. C. 1506], at the same time, namely on Saturday [die Saturni], the eighth of the month of August, a haired star appeared around the pole, above the Seven Stars [ſupra Septiſtellium]. On the second night [Alterâ nocte], among the seven stars mentioned before, which are called the Chariot [currus]; finally, during those other nights [ſub iis aliis noctibus], sinking continuously through Cancer, Leo and Virgo, and bending down near the horizon of the north, it disappeared on the Vigil of the Assumption of Mary [in Vigilia asſumptionis Mariæ]. M. Michovius, in *Hist. Polon.*, vol. 2, p. 254 [in Hiſt. Polon. tom. II, pag. 254.].

AD 1511. [Anno Chriſti 1511.]

In AD 1511 [A. C. 1511] a comet of terrible aspect appeared in Egypt, Arabia and Ethiopia, from May 30 [à 30 Maji] to the third of July [ad tertium Julii], blazing in the sign of Leo. Rockenbach [Rockenb.]. D. Christiani [D. Chriſtian.]. Herlicius, Eckstorm [Eckſtormius].

AD 1512. [Anno Chriſti 1512.]

In AD 1512 [A.C. 1512], in March and April, a comet of a blood-red colour [coloris ſanguinei] appeared. Riccioli [Ricciolus], from Petrus Surdus [ex Pet. Surdo].

AD 1513. [Anno Chriſti 1513.]

[Margin: Cometa variis coloribus & Caudâ oblongâ.] *A comet of various colours and with an oblong tail.* In AD 1513 [A. C. 1513] another comet was seen from the end of December until February 19 [19 Februar.] of the following year, with various colours and an oblong tail, which ran out from the end of Cancer to the end of Virgo. And it was seen the whole night. Riccioli [Ricciolus].

AD 1515. [Anno Chriſti 1515.]

In AD 1515 [A. C. 1515] a comet was seen in Italy, resembling the nature of the Moon [lunæ naturam referens], and running through the twelve signs within a short space of time. Rockenbach [Rockenbachius].

Around the year 1515, more or less [plus minus], a comet of lunar nature appeared, says Myzaldus, p. 192 [Myzaldus pag. 192.].

AD 1516. [Anno Chriſti 1516.]

In AD 1516 [A. C. 1516] a comet appeared for some days, shortly before the death of Ferdinand, King of Spain [Ferdinandi Reg.Hiſpan.]. Rockenbach [Rockenb.]. D. Christiani [D.Chriſtian.]. Bizaras, *Hist. Gen.*, book 19, p. 146 [Bizar. Hiſt.Gen.l. 19,pag. 146.]. Eckstorm [Eckſtormius], Eberus, Paulus Jovius [Paul. Jovius].

In AD 1517 [A. C. 1517] a comet appeared in Leo. Eckstorm [Eckſtorm.], from Herlicius [ex Herlicio]. But whether this comet was wholly different from the previous one, I very much doubt [omninò dubito], since no one else mentions it.

AD 1521. [Anno Chriſti 1521.]

[Margin: Cometa inſtar Lunæ dichotomæ.] *A comet like the Moon at dichotomy.* In AD 1521 [A. C. 1521] there was a conspicuous comet [Spectabilis fuit Cometes] in the month of April at the end of Cancer, with short hair, bright, and like the Moon at dichotomy [Lunæ dichotomæ]. On the testimony of Petrus Surdus [Teſte Petro Surdo]. Riccioli [Ricciolus].

AD 1522. [Anno Chriſti 1522.]

In AD 1522 [A. C. 1522] a comet appeared toward the setting of the Sun [versùs occaſum Solis], resembling the nature of Saturn. Rockenbach [Rockenbachius].

Would that this had been as false as the comet of this (Saturnine) picture [hujus (ſaturninæ) picturæ Cometa], seen toward the western region around the year 1522, has shown it to be most true, as observers who were most sharp-sighted [oculatiſſimi] and at the same time diligent, and who are still living, have assured me. Myzaldus, p. 177 [Myzaldus pag. 177.].

AD 1523. [Anno Chriſti 1523.]

In AD 1523 [A. C. 1523] Junctinus noted that a comet appeared in November, a harbinger of a great flood. Prætorius, Rockenbach [Prætorius,Rockenbachius].

In AD 1523 [A. C. 1523], on the fifth day before the Kalends of November [QuintoCalend. Novembr.], a comet appeared in the Kingdom of Naples; and the sky was seen to be utterly ablaze from frequent flashes, thunderclaps and lightning bolts falling to the earth; the earth shook, and there followed, from the bursting of a cloud [ex rupturâ nubis], so great a flood, etc. [& c.]. Lycosthenes.

In AD 1524 [A. C. 1524] a comet appeared. Eckstorm [Eckſtormius].

In AD 1525 [A. C. 1525] D. Cramerus reports that a comet appeared, from Herlicius's treatise on the comet of the year 1618, chap. 8 [ex Herlic. tract. de Comet. anni 1618, cap. 8.].

AD 1526. [Anno Chriſti 1526.]

[Margin: Cometa igneo enſi ſimilis.] *A comet like a fiery sword.* In AD 1526 [A. C. 1526], from August 23 to September 23 [à 23 Auguſti, ad 23 Septembr.], a comet like a fiery sword was seen. Riccioli [Ricciolus], from Petrus Surdus [ex Petro Surdo].

AD 1527. [Anno Chriſti 1527.]

[Margin: Vix imaginari mihi poſſum,hocce phænomenum fuiſſe Cometam.] *I can hardly imagine that this phenomenon was a comet.* In AD 1527 [A. C. 1527], in the territory of the Palatinate [In Ditione Palatinatus], a comet of huge and monstrous size was seen and observed in the west on the 11th day of December [11 die Decembr.]. It was entirely bloody, terrible with cloud [nube terribilis], and surrounded on this side and that by stars, spears and swords, and also by severed heads. Bizaras, book 19, near the end [Bizar. lib. 19, ſub fin.].

In AD 1527 [A. C. 1527], on August 11 [Die 11 Auguſti], a comet first shone in the sky at the very start of the morning [de mane ſummo], around the fourth hour, seen by almost the whole of Europe. Contrary to the nature of other comets, it had in it a kind of hand, stretching out a sword and brandishing threats. Wolf., *Centur.* 16, p. 293 [Wolf. Centur. 16, pag. 293.].

In AD 1527 [A. C. 1527], on October 11 [Die Octobr. 11] (others: on August 11 [alii die 11 Auguſti]), in the morning, around the fourth hour, not only in

that part of Uuestria [Uueſtriæ] over which the Counts of the Rhine [Comites Rheni] rule, but also throughout almost the whole of Europe a terrifying comet was seen, and it lasted for an hour and a quarter [per horam unam & quadrantem], blazing daily. It rose from the Subsolanus [A Subſolano] and climbed toward the south and the west, but it was most conspicuous under the north [ſub Septentrione]. [Margin: Mirum ſanè phænomenum.] *A wonderful phenomenon indeed.* Its length was immense, its colour blood-red, ending in saffron. Its summit had the form or the appearance of a bent arm, in whose hand a sword of huge size was seen, as of one just about to strike. At the point of the sword and on both its edges three stars of no small size appeared; but the one that shone at the point was larger than the other two. From these, dim rays were seen in the form of a hairy tail. On the sides were seen rays from top to bottom, shaped almost into the likeness of spears [in ſpeciem haſtarum ferè deformati], and smaller swords, of a diluted blood colour, among which were human faces, bristling with hair and beards, of the colour of a blackish cloud. These glowing red things were stirred with such terror and horror [tanto terrore horroreq́; rutilantia mota ſunt] that some spectators were almost lifeless with fear. Rockenbach, Lavatherus [Rockenb.Lavath.]; for the description itself [cujus ipſam deſcriptionem], see among the *Meteora* [inter Meteora].

Eckstorm [Eckſtormius] says that it appeared in Leo, from Herlicius and Gemma [ex Herlicio & Gemmâ].

No kind of comet is to be compared, in the greatness of its horror and in the appearance of divinity, with the one that Father Creusserus [Pater Creuſerus] records as seen in 1527, on the 11th day of December [Decemb. 11die], in the west, in the territory of the Palatinate. It was entirely bloody, with a terrible cloud [nube terribili], surrounded on this side and that by stars and spears and swords, and also by severed heads. Many fell into sickness and syncope [Syncopen] from this sight alone. Cornelius Gemma, *de natura div. Char.*, chapter 8 [Corn. Gemm. de naturâ div. Char. capite 8.].

AD 1528. [Anno Chriſti 1528.]

In AD 1528 [A. C. 1528] another comet was seen in Pisces, from January 18 [à die 18 Januar.], in opposition to Saturn. Riccioli [Ricciolus].

AD 1529. [Anno Chriſti 1529.]

[Margin: An quatuor Cometæ ſimul apparuerint valdè dubito.] *I very much doubt whether four comets appeared at the same time.* In AD 1529 [A. C. 1529] some record that four comets appeared, set opposite one another, turning their tails toward the four quarters of the world. Others, however, write that it was a chasm [Chaſma], turning itself toward the four cardinal points of the world. Rockenbach [Rockenb.]. Prætorius.

AD 1530. [Anno Chriſti 1530.]

In AD 1530 [A.C. 1530], as Heller [Hellerus] noted, a comet appeared. Myzaldus, in the catalogue [in Catalog.] (different from the comet of the year 1531). Rockenbach and Prætorius also do indeed ascribe to the year 1530 a comet other than that of the following year 1531 [alium, qvem ſequenti 1531 aſcribunt Cometam], but they describe both its duration and the motion of each in the same words; perhaps they took it from Lycosthenes [ex Lycoſthene], who lists a comet in the same words both under this year and under the next.

In AD 1530 [A. C. 1530], during the Diet of Augsburg [Inter Comitia Auguſtana], in the month of June, a comet appeared. Saxon Chronicle [Chronic. Sax.]. Eckstorm [Eckſtormius].

AD 1531. [Anno Chriſti 1531.]

[Margin: Cometa matutinus deinde veſpertinus factus eſt.] *A morning comet afterwards became an evening one.* In AD 1531 [A. C. 1531], from August 6 [A die 6 Auguſti] until the third of September [ad tertiam Septembris], we saw a comet in Leo, advancing as far as the beginning of Libra with a rather slow motion; two eclipses had preceded it in the previous year. Eberus. Myzaldus, in the catalogue [in Catalogo]. H. Mutius, book 31, *Chron. German.* [H. Mutius, Lib. 31. Chron. German.].

In AD 1531 [A.C. 1531] a comet was seen in Germany, Italy and France [In Germaniâ, Italiâ & Galliâ], reddish or rather yellow, around the sixth day of August; at first, for some days, it appeared in the morning before sunrise; then it followed the Sun, and toward evening, after sunset, it was seen for about three weeks, until the third day of September. Its course was through Cancer, Leo, Virgo and Libra, where it ceased to be seen. Lavatherus [Lavather.], from Carion [ex Carion.]. Schleidan. And Prætorius and Rockenbach [Rockenbachius] describe the comet of the preceding year in almost these very words. Likewise Jacobus Fincelius, *de Miraculis*. Wolf., from Fritscherus [ex Fritſchero], vol. 2, p. 619.

It is set out by Apian [Ab Appiano] in the *Astronomicum Caesareum* [in Aſtronomico Cæſareo] from observations.

[Margin: Obſervatio Cometæ 1531 ab Appiano tradita.] *Observation of the comet of 1531, handed down by Apian.*

August, day	Comet, longitude	Latitude	Tail, longitude	Latitude
13	19° 15′ ♌	23° 15′ *B.*	10° 57′ ♌	36° 44′ *B.*
14	23° 39′ ♌	23° 2′ *B.*	19° 18′ ♌	39° 45′ *B.*
15	29° 24′ ♌	22° 0′ *B.*	21° 2′ ♌	34° 32′ *B.*
16	4° 37′ ♍	22° 1′ *B.*		
17	9° 14′ ♍	21° 25′ *B.*		
18	15° 30′ ♍	20° 12′ *B.*		
22	1° 23′ ♎	16° 32′ *B.*		
23	2° 51′ ♎	14° 31′ *B.*		

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In AD 1531 [A.C. 1531] a comet shone on August 15, or a little earlier, as some hold, at the beginning of the sign of Leo, at first in a straight line with the two outermost ones in the Tail of Ursa Major [in Caudâ Urſæ majoris]. Bizaras, *Histor. Germ.*, book 20, page 490. Cornelius Gemma, in *Cosmotric.*, chapter 8 [in Coſmotric. cap. 8.].

In the year 1531 [Anno 1531], in the month of August, a comet of the kind that are called Pogoniae [Pogoniæ] appeared in the region of the setting Sun. In the next year either the same one or another like it was seen in the morning, in the part of the rising Sun. Camerarius [Camerar.], in the life of Melanchthon [in vita Melancht.]. It wandered through Leo, Virgo and Libra. Milichius on Pliny the Elder [in Plinii], book 2, chapter 25.

AD 1532. [Anno Chriſti 1532.]

[Margin: Cometa triplo major Jove.] *A comet three times larger than Jupiter.* In AD 1532 [A.C. 1532], in the month of September, a comet was again seen, two hours in the morning before sunrise, and toward the eastern quarter [ad Orientalem plagam]. When I saw it, it was in Virgo, unless I am mistaken, and it had stretched out a radiant tail between the south and the west. Lavatherus [Lavath.], from Carion. Likewise Jacobus Finkius, *de Miraculis*. It began to be seen at the end of September, with a certain dark pallor, and it lasted three whole months. It was quite terrible in its flame; for it surpassed the other comet, which we had seen the year before, both in size and in duration. Lavatherus, from Milichius [ex Milichio].

[Margin: Obſervatio Cometæ 1532 ab Appiano habita.] *Observation of the comet of 1532 made by Apian.* In AD 1532 [A.C. 1532] a comet was seen from September 23 until November 10, before sunrise, for two hours, and for several weeks, stretching out a very long tail toward the south and the west [verſus Meridiem & Veſperam]. Although there are some who have affirmed that it shone until December 3, and advanced from the fifth degree of Virgo to the 8th degree of Scorpio. Rockenbach [Rockenbachius].

The second comet of the year 1532 [Secundus Cometa anno 1532] shone in the eastern region; it began to be seen on September 25, and up to the day November 20 it was observed by me seven times, and most diligently, says Apian [Appianus] in the *Astronom. Caesar.* [in Aſtronom. Cæſar.], where he publishes it from his own observations.

[Margin: Cometa triplò major Jove.] *A comet three times larger than Jupiter.*

694 The table is ruled in five columns, headed in three printed lines: Auguſt. die.; Cometæ Longitudo. Gr. Min.S.; Latitud. Gr. Min.; Caudæ Longitudo, Gr.Min. S.; Latitud. Gr.Min. The word Cometæ stands over the second column only and Caudæ over the fourth only. Horizontal rules divide the days into three groups: 13–15, 16–18 and 22–23. The two tail columns are blank from the 16th onward. B. is printed after every latitude and is not expanded on the page. The table stands at the left of the measure, with the following entry (In AD 1531 … cap. 8) set in a narrow column beside it, and the side-note in the outer margin beside its first three rows.

Date	Head of the comet, longitude	Latitude	Tail of the comet, longitude	Latitude
October 2	18° 24′ ♍	13° 44′ *M*		
October 3	1° 25′ ♍	10° 12′ *M.*	26° 44′ ♌	13° 8′ *M*
October 14	0° 0′ ♎	0° 0′		
October 19	5° 46′ ♎	4° 51′ *S.*		
October 31	21° 30′ ♎	13° 15′ *S.*		
November 1	23° 57′ ♎	14° 42′ *S.*		
November 8	3° 35′ ♏	19° 36′ *S.*		

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In AD 1532 [A.C. 1532] a comet was seen, always in the morning, before the Sun. The star was three times larger than Jupiter, but its coma or beard was of the length of two arms. It began to be seen on the 22nd day of September and lasted until the 8th day of December, which made about 71 days. Fracastoro [Fracaſtor.], *Homocentr.*, sect. 3, chapter 23, fol. 59.

AD 1533. [Anno Chriſti 1533.]

[Margin: Appiani obſervatio Cometæ 1533.] *Apian's observation of the comet of 1533.* The third comet appeared in the year 1533 [anno 1533], in the month of June; although it shone for many days, it was nevertheless seen by me no more than four times. For I learned very quickly that in this one too the tail is generated by the Sun, so that, as a more diligent observer, I would seem likely to spend my effort in vain. First of all, I prepared myself for the first observation on June 18 [die 18 Junii], and there at once I perceived that the comet occupied 3° 40′ of Gemini, deviating 32 degrees to the north of the ecliptic, at no great distance from the star called Algenib, but directing its tail toward that star, the same fixed star. Second, on the 21st day of the same month, looking at the comet, I found it in 29° 20′ of Taurus, elongated 36° 20′ from the ecliptic, and its tail equal to 15 degrees in length. Third, examining the comet on June 23 [23 Junii], I found it in 21° 30′ of Taurus, carried 40° 30′ from the ecliptic. Fourth, on the 25th day of the month, the comet was found to occupy degree 15 of Taurus, moved 43 degrees [Gradib. 43] from the ecliptic. [Margin: Hic Cometa factus eſt perpetuæ apparitionis.] *This comet became one of perpetual*

[695] The table is ruled in five columns and headed in three printed lines, the first column without a head: Capitis Cometæ., set across the second and third columns, over Longitudo. Gr.Min. S. and Latitudo. Gr.Min.; Caudæ Cometæ., set across the fourth and fifth columns, over Longitudo. Gr.Min.S. and Latiiudo. Gr. Min. [recte: Latitudo.]. The first column gives the dates as Octob. and Nov. with the day. A horizontal rule divides the rows into two groups: October 2–19 and October 31–November 8. The tail columns carry figures only on October 3. M. and S. are printed after the latitudes as shown, M without a point on October 2 and in the tail column, and no letter after 0° 0′ on October 14; they are not expanded on the page. The table stands at the left of the measure, with the following entry (In AD 1532 … about 71 days) set in a narrow column beside it, and the side-note in the outer margin beside its head.

appearance. That comet, however, could never set, because of its nearness to the Arctic Pole; for it was so close to the Pole that it could not touch the horizon, etc. But I know that this comet will give rise to no little disagreement among astrologers and philosophers, because its motion is against the order of the signs: for it went back from Gemini into Taurus. Apian [Appianus].

In AD 1533 [A.C. 1533] a comet of enormous size was seen at the end of June, for two months, July and August, toward the north, outside the zodiac, not far from Perseus [à Perſio], running back into Gemini, Taurus and Aries, and stretching its tail toward the northern west [versùs occaſum borealem]. Rockenbach [Rockenb.]. Lavatherus [Lavath.], from Milichius [ex Milich.]. Jacobus Fincelius [Iacobus Fincelius], *de Miraculis*.

[Margin: Inſtar Rompheæ apparuit.] *It appeared like a rhomphaea.* In this year a comet was seen whose very long tail represented a rhomphaea [Rhomphæam], reports Wolf., from Brügn., page 396, vol. II.

Fracastoro [Fracaſtorius] holds that the star itself (the head of the comet) was a little larger than Jupiter [Iove], but that the tail was of such length that it equalled the length of a soldier's spear in the sky. *Homocent*., fol. 59.

[Margin: Trium Cometarum directio à Fracaſtorio notata.] *The direction of the three comets noted by Fracastoro.* The same Fracastoro [Fracaſtorius] adds: In passing, however, we shall not keep silent about what was common to these three comets, etc. For all of them always cast their coma or beard directly toward the part opposite the Sun, so that if the Sun had been on the equinoctial toward the east, the beard stretched out on the equinoctial toward the west; and as far as the Sun had turned aside to one part, so far did that beard itself always turn to the opposite side; which, we read, that comet too did which appeared in the year 1472.

Note: As if these comets, or others, always stuck to the equinoctial, etc.; for Fracastoro does not set this out very aptly [parum enim commodè hæc exponit Fracaſtorius].

In AD 1533 [A. C. 1533], around the end of the month of July, a comet shone all night near the stars close to the northern ones [ad Stellas propinquas Septentrionalibus]. Camerarius [Camer.], in the life of Melanchthon [in vita Melancht.]. Eckstorm [Eckſtormius].

In the year 1533 from the birth of Christ [A. à nato Chriſto 1533] a comet moved against the order of the signs, from Gemini into Taurus, and then into Aries. Daniel Santbech [Dan. Sandbech.], in his *Problem. Astron*., prop. XIX, page 61.

[Margin: Cometa perpetuæ apparitionis & Retrogradus.] *A comet of perpetual appearance, and retrograde.* In AD 1533 [A.C. 1533], around the beginning of July, another in 5° of Gemini, near the star Hircus [circa ſydus Hirci], latitude 24° [Lat. 24 grad.], declination 48 [declin. 48]: it never set, yet it was carried round by the motion of the first mobile [motu primi mobilis], and then also by its own motion against the succession of the signs, in a new way, around the Milky Way (as the father notes) through the constellation of Cassiopeia [per

Casſiopeæ Sydus] as far as Cygnus, where only then did it vanish. Cornelius Gemma, in *Cosmotric.*, book I, chapter VIII, page 211.

We saw a comet in the year 1533, in July, moving from the star Hircus [ab Hirci Sidere] along the course of the Milky Way, through the constellation of Cassiopeia; that is, toward the preceding signs [in præcedentia Signorum] and at the same time far to the north [in Boream]. Gemma Frisius, *de Radio Astron.*, chapter 19.

AD 1538. [Anno Chriſti 1538.]

[Margin: Cometa Caudam habens 30 grad.] *A comet having a tail of 30°.* The fourth comet in order was seen in the year 1538, in the month of January, from the 17th to the 21st of the same month, after the setting [poſt occaſum], raising its tail most straight toward the zenith. Its true place in the ecliptic was 5° of Pisces, northern latitude 17° [Latitud. Septentrion. Grad. 17.]. The tail spanned nearly 30° in length, but with a narrower width [anguſtiori tamen Latitudine]. Apian [Appianus].

In AD 1538 [A.C. 1538] Lavatherus [Lavather.] reports, from the Annals of Stumfius [ex Annal. Stumfii], and Achilles Gasser [Achill. Gasſarus], who described this comet, that a comet of fiery colour appeared in the west for eleven nights, with its tail turned toward the west.

In AD 1538 [A. C. 1538], on January 22, a dark, pale star [Sydus] was seen, with a very long tail drawn straight upward, in 9° of Pisces, in latitude 11°, in a straight line between the neck and the shoulder of Pegasus. Bizaras, *Histor. Genuens.*, book 21, page 508.

Besides this comet of the year 1538, Rockenbach also lists two in the year 1537. The first of them appeared in the month of January, in the evening toward the west, with its tail stretched out toward the east; it was soon followed by another in the sign of Taurus, not far from the Head of the Dragon [à Capite Draconis], which directed its coma toward the south and shone for three whole weeks. From Lycosthenes [ex Lycoſthene].

[Margin: Sidus obſcurum, & pallidum, caudâ erectâ.] *A dark and pale star, with its tail raised.* In AD 1538 [A. C. 1538], the father [Parens] (says Cornelius Gemma [Cornel. Gemm.], in *Cosmocr.*, book I, chapter 8) testifies that he observed a dark, pale star [Sydus], with a very long tail drawn straight upward, which he reckoned on January 22 in 9° of Pisces, in latitude 11°, in a straight line between the neck and the shoulder of Pegasus.

In AD 1537 [A. C. 1537] a comet appeared in January in the sign of Pisces, throughout Germany, in the evening toward the west; it raised its tail toward the east. Soon, in May, another [Majo mox alius], toward the west in Taurus, not far from the Head of the Dragon, which raised its coma toward the south and lasted three weeks. Lycosthenes. Jacobus Fincelius [Iacobus Fincelius].

Lycosthenes seems [Videtur Lycoſthenes], and Rockenbach following him [& ex eo Rockenbach], to put into this year by mistake two comets of the two following years [duos duorum ſequentium annorum Cometas per errorem in

hunc annum conjicere]. For the description of each is entirely the same in both places [Nam deſcriptio Utriusque utrobique prorsùs eadem eſt]. Nor is it likely that Apian, since he numbers his 5 comets [V Cometas] in order, would have neglected these two. Finally, the ascending node of the Moon [Nodus Lunæ evehens] was in the sign of Taurus only in the year 1539. Although, if the comet was in Taurus while the Sun stood in Gemini, it could not have been seen in the evening with its tail turned toward the south.

AD 1539. [Anno Chriſti 1539.]

[Margin: Appiani obſervatio.] *Apian's observation.* The last of the comets, and the fifth in number, shone in the year 1539, from the sixth day of the month of May until the 17th of the same month, when it was also seen by me at hour 10 of the night [horâ noctis 10], standing 19° above the horizon, etc., near the vertical circle, except that it was a little less than 5 or 6° more southerly [niſi quod 5 aut 6 grad. paulò minus Auſtralior eſſet]; it was situated in 17° of Leo, 3° from the ecliptic toward the south. The difference between the Sun and the comet appears as 72°, etc. That comet was exceedingly slender and dim [perquàm exilis & obſcurus], putting out a shorter and narrower tail, etc. Apian [Appianus].

In AD 1539 [A. C. 1539] a comet shone again at the beginning of May, in the western quarter, at the beginning of the night; it turned a white and dim tail toward the south. Lavatherus [Lavath.], from the annals of Stumfius [ex Stumf. annal.]. Jacobus Fincelius. Rockenbach [Rockenb.] adds that it appeared for three whole weeks in the sign of Aries. Lycosthenes [Lycoſth.]. Büntingus [Bünting.]. Eckstorm [Eckſtorm.]. Mizaldus, from Heller [ex Hellero], teaches that this comet was seen under Taurus: perhaps at the beginning it was northern and eastern.

[Margin: Sidus pallidum & caudâ brevi.] *A pale star, and with a short tail.* In AD 1539 [A. C. 1539], in the month of May, they describe another, a pale star [Sidus, pallidum] with a short tail, in 5° of Leo, northern latitude 12° [latitud. Septentrion. 12 Grad.], which moved from the ecliptic toward the south [in Auſtrum]. Bizaras, *Histor. Genuens.*, book 21, page 508.

In AD 1539 [A. C. 1539] Gemma Frisius too [& Gemma Friſius] observed a comet in the month of May, pale, with a short tail, in 5° of Leo, northern latitude 12° [Latit. Septent. 12°], which advanced from the ecliptic toward the south. Cornelius Gemma [Corn. Gemma], *Cosmocrit.*, book 1, chapter 8.

In AD 1539 [A. C. 1539], on the 6th day of May, a comet shone in Taurus for three whole weeks. Jacobus Fincelius.

Lycosthenes also asserts that a comet was seen in the year 1540, the cause of the most intense heat and drought in that year [caloris & ſiccitatis eo anno vehementiſſimæ cauſam].

AD 1541. [Anno Chriſti 1541.]

[Margin: Cometa formam Draconis referens.] *A comet resembling the form of a dragon.* In AD 1541 [A. C. 1541] a comet terrible to see, resembling the form of a dragon [formamq́; Draconis referens], was seen on the 21st day of August, having a fiery tail. Rockenbach.

In AD 1541 [A. C. 1541], on the 21st day of August, a comet appeared in the form of a dragon, with a long, fiery tail. Schosserus, Eckstorm [Eckſtormius].

AD 1542. [Anno Chriſti 1542.]

In AD 1542 [A. C. 1542] a comet terrible in aspect, blazing above Constantinople, was seen for 40 days. Rockenbach [Rockenbachius].

In AD 1542 [A. C. 1542] a horrible comet was seen at Constantinople for 40 days. Fincelius, Eckstorm [Eckſtorm.], from Schosserus [ex Schoſſero].

AD 1545. [Anno Chriſti 1545.]

In AD 1545 [A. C. 1545] a comet appeared in the west, of a blood-red colour; it was seen to blaze for some days, and fire fell from the sky with it [igne ſimul de cœlo cadente]. Rockenbach [Rockenbachius].

I remember that 24 years ago (from the year 1568 or 69), when such a flame had shown itself, the eyes and minds of many, etc. Camerarius.

AD 1554. [Anno Chriſti 1554.]

[Margin: Cauda ignea.] *Fiery tail.* In AD 1554 [A. C. 1554] a comet of fiery colour, together with other wonders appearing in the sky [in cœlo aprentibus] [recte: apparentibus], and which turned its tail toward the setting of the Sun, was seen for some days. Rockenbach [Rockenbachius].

AD 1556. [Anno Chriſti 1556.]

A comet was also seen in the year 1556 [Anno 1556], at the beginning of March; Iohann. Hommelius [Johannes Hommel], once a distinguished mathematician, described it carefully. [Margin: Obſervatio Homelii.] *Homelius' observation.* It was no trouble to append the following from his own notes [Ex ipſius annotatione hæc ſubjicere non piguit]. On the 5th day of March it stood near the left wing of Virgo, above Spica; on the 8th day, below the knee of Boötes; and on the ninth day, near Arcturus; so that it seemed to approach the northern pole of the zodiac as if along the circumference of a great circle, that is, by the most direct path; and at that time it traversed more than 15° of a circle of the heavens in one day. [Margin: Cometæ Curſus.] *Course of the comet.* As it ascended toward the northern pole of the zodiac, however, leaving that pole on its right, it approached the pole of the world with great speed; and from there, descending as if from a summit, it made for Saturn, which was then in Aries. And as earlier it had proceeded from Libra against the order of the signs (in longitude), so afterwards it imitated the motion of Saturn, or progressed [Saturni motum imitans, ſive progreſſus eſt], through Andromeda

to the sign of Pisces, where it was extinguished. Both its rays and its body changed. [Margin: Directio Caudæ.] *Direction of the tail.* And the rays were directed, in the evening toward the south, after midnight toward the west. Nor did it have its coma [Comam] turned away from the Sun until it was less than a quadrant of a circle away from the Sun. This too happened to it: being farther removed from the zodiac, it could be seen morning and evening; and at times it was not hidden below the horizon. A more accurate description may be sought in the booklet of D. Camerarius [ex D. Camerarii libello]. Note: if the comet went on through Andromeda to the sign of Pisces, that certainly happened against the sequence of the signs [contra ſeriem Sign.]; for Andromeda is in the sign of Aries.

In the same year 1556 [Ejusdem anni 1556], in the month of March, on the 4th day, a huge and bright star [ſydus], drawing a flame-bearing hair along a broad track, which began to be seen in 8° of Libra and in opposition to Mars, burned for about 12 days. At first it stretched out its funereal and oblong tail toward the east; but since it was moving very swiftly from day to day from the ecliptic toward the north, it began to stretch it out toward the south. Bizaras, *Histor. Genues.* [Hiſtor. Genueſ.], book 23, page 558.

In AD 1556 [A. C. 1556] a comet was seen from the eighth of March (some put the beginning, others the fifth day of March) until the end of April. After it had hurried on a very swift course from Spica to Boötes, or to Ursa Major and Minor, then directing its course from there back toward Cepheus and Saturn, which was in the sign of Aries, it went ahead of the Sun before Easter Day, so that it was seen several times before sunrise. Rockenbach [Rockenbachius]. Compare Crüger, *Uranodromus*, pages 65 and 76 [Confer Krügeri Uranodrom. pag. 65 & 76]. See the diagram of the motion of this comet in Lycosthenes [apud Lycoſthenem].

[Margin: Cometa ſex Signa peragravit.] *The comet traversed six signs.* When that (flame) of two years before (from the year 1558), another one, with as it were a stretched-out beard of thin and pale hairs [altera quaſi porrecta barbâ tenuium pilorum & pallidorum], which was thought to have vanished in the autumn, had appeared again in the month of March, it was hidden for three months, not extinguished. Camerarius [Camerar.], page 1.

As for the one we saw two years ago [biennio], it is agreed that, rising from the sign of Virgo to the vertex of the world and sliding down through the convex of the sky to the opposite sign of Pisces, it could no longer be seen. These places fall in the dodecatemory [dodecatemorion], that is, as it were, in the twelfths [uncias] of the zodiac circle [circuli ſigniferi], of Libra and Aries. [Margin: Cometa ſub circulo ferè maximo ſex Signa peragravit.] *The comet traversed six signs, almost under a great circle.* So the progress of that star [ſyderis], or flame, accomplished half the orb by its motion; nor did it wander far outside the great circle that would be drawn through two points, one at about 11° of Libra [ad partem circiter XI. Libræ], the other at 11° of Aries [ad P. XI. Arietis]. Moreover, it could clearly be detected by observation that it was making for

the star of Saturn; yet the closer it approached it, the slower its progress was. Camerarius [Camerar.], page 5.

Also, the face of the other flame that was seen was that of a light casting thin rays, and more pale than glowing red, but scattered, from a globe bright with flame [de globo flamma nitido]. We did not doubt that it was the one the Greeks designated by the name Pogonias, when the mane [juba] is let out in the likeness of a long beard, as Pliny the Elder says. The Greeks also describe it thus: that the part which stretches out and stands out below is seen with scattered rays, whereas the upper part is more compressed and narrower [cum ſit coactior & arctior ſuperior]. Camerarius, page 6.

Certainly the one that shone two years before was found to have gone by a direct path to the star of Saturn, which was then found below the sign of the more northern Fish [infra Piſcis magis Aquilonaris Signum], in the dodecatemory of Aries. But a certain one, carried across in a manner unknown to us through the north [per Septentriones], from the east round again to the east, through that convex of the sky which is seen by those who have the north as their high vertex, arrived [pervenit]. It lingered long, as if in the chains of Andromeda, having been carried to her from Cepheus, so that it passed over Italy for several days. Camerarius [Camerar.], page 9.

[Margin: Cometa æqualis fermè Lunæ dimidio.] *A comet almost equal to half the Moon.* At the beginning of March in the year 1556 [anno 1556] there appeared a comet star [Cometes Stella], almost equal to half the Moon, with hairs not so very long, nor steady, but glowing red as if with fires, and as in torches while the wind blows. It was dusky, red and turbid [Fuſca erat rubens & turbida]. [Margin: Prima Cometæ 1556 apparitio.] *First appearance of the comet of 1556.* On the fifth day of March, near the middle of Libra, when we first saw it. But not at the very pole of the world: earlier it declined 60° [ſexaginta partibus] from the equinoctial circle. [Margin: Curſus ejus velociſſimus.] *Its very swift course.* So in four whole days it moved 75° [ſeptuaginta quinque partibus] from east to west, and 30 [triginta] from south to north. Then indeed it rained continually, and when the rain stopped it did not appear. In Germany it appeared until the middle of April, etc. For the motion of this comet, with the observation of the circles and of the fixed stars, as it was seen and described for twelve days at Vienna in Austria [Viennæ Auſtriæ] by Paulus Fabritius [Paul Fabricius] of Lauban [Laubenſi], see Lycosthenes.

Toward the beginning of March of the year 1556 [anni 1556], a comet, almost equal to half the Moon, with hairs not long, nor steady, but glowing red as if with fire, as in torches when the wind blows on them [ut in tædis, dum ventus afflat]; it was dusky, red and turbid. Kepler [Kepl.], page 102, *Physiol. Com.* [Phyſiol. Com.], from Cardanus [ex Cardano].

[Margin: Cypr[[i/t]]ani Leovitii obſervatio Cometæ 1566.] *Observation of the comet of 1566* [recte: 1556] *by Cyprianus [?] Leovitius.* In AD 1556 [A.C.1556] a comet appeared to us here at Augsburg [Auguſtæ vindelicorum], which I first began to observe in the year 1556 [A. 1556], on the 7th day of March, at hour

9 after noon [horâ poſt Meridiem 9], and found to be situated not far from the Vindemiatrix [Vindemiatore]; that it had nevertheless shone some nights before, trustworthy men testified. This we also learned from the observation of the most learned man Paul Fabricius, the royal mathematician [Viri Doctiſſimi Pauli Fabricii Mathematici Regii], where he puts the beginning of the comet on the 4th day of March, in 8° of Libra.

[Margin: Prima apparitio ſecundùm Paul. Fabri[[c/e]]ium.] *First appearance according to Paul Fabricius [?].* He depicted its configuration and progress excellently and learnedly [Depinxit autem egregiè & eruditè conſtitutionem & progreſſionem ejus] up to the 15th day of March. For from day to day it was carried more and more toward the north [in Aquilonem], very swiftly, in the way he himself demonstrated. I saw it until the 17th day of March, until it had reached Cepheus. Afterwards, on the two following nights, clouds had covered the sky in part; had they been absent, it could without doubt have been seen then too. The distinguished man D. Achilles P. Gasser of Lindau [Vir Clar. D. Achilles, P. Gaſſarus Lindavienſis], doctor of medicine and an outstanding mathematician, also reported to me in this way about his own observation. [Margin: Caudæ directio.] *Direction of the tail.* Further, the tail of that comet at first stretched toward the west. Then, since it attained so great a latitude from the ecliptic, it began to direct it toward the south. [Margin: Color.] *Colour.* But the colour at the extremity was always pale, livid and as if leaden, and so toward the head of the star it gradually appeared brighter, so that you would say it truly consisted of the nature of Saturn and Mercury. Thus Cyprianus Leovitius, in his work on eclipses [Hæc Cyprianus Leovitius in Opere ſuo de Eclipſibus].

[Margin: Obſervatio Cornelii Gemmæ, Cometæ 1556.] *Cornelius Gemma's observation of the comet of 1556.* Above all there occurs that dire portent of a comet which appeared almost two years [?] after the earthquake [poſt terræ motus], in the year of Salvation 1556 [anno Salutis 1556], from the beginning of March (as several assert) until April 23. Paul Fabricius [Paulus Fabritius] observed its course most diligently, but only from March 4 until the 13th. I, for my part, being then a little more negligent in mathematics [paulò ſupinior in Mathematicis], turned my attention to it, but did not apply equal industry of observation to every single day. [Margin: Directio Caudæ.] *Direction of the tail.* Yet I found this noted by me: that on the third of March it stood not far from the zodiac itself, near Libra, with a very long tail stretched out toward the west, along a straight line from the body of the Sun through the head of the comet into the opposite part. A little before the nearness of the Sun took it from our sight, having made its path almost through the pole of the zodiac, it had reached the seat of Cassiopeia [ad ſedem Caſſiopeæ] around April 18. When I had at last examined its place with instruments applied, I found it not far from the pole of the zodiac [à Signiferi polo], but yet in the dodecatemory of Leo, if it is referred to the zodiac. [Margin: Quo loco & tempore evanuerit.] *In what place and at what time it vanished.* Those who investigated more correctly hold

that it expired not far from the place which the new star [Sydus novum] now occupies, and I rather think so, since on a certain other tablet I found it written separately with my own hands that the comet was seen until the 23rd day of April. I believe too that its head, before it presented itself to us, had passed across the zodiac [Signiferum]. [Margin: Motus.] *Motion.* From the beginning of March, moreover, it began to move from the sign of Libra upward toward the pole, but obliquely and toward the rear parts [in poſteriora] in longitude, toward the beginning of Libra; it went on at times 8 or 9° in latitude, now a little slower, now faster. On the third day it was only 6° away from Spica, in a straight line exactly between Spica and the lower one under the girdle of Virgo [inferiorem ſub cingulo Virginis], with its tail facing toward the left wing. From here, climbing almost along a straight line, it came as far as the Tropic, or a declination of 23° [declin. 23 graduum], around the eighth day. [Margin: Factus eſt retrogradus.] *It became retrograde.* Then, having gone back some degrees, suddenly toward the end of Leo it began another straight line of course in latitude [aliam rectam lineam diſcurſus in Latitudinem auſpicata eſt], running straight to the pole of the zodiac until the twenty-third (from which it was not far), having wandered hastily through all the angles of the signs Leo, Cancer, Gemini, until it had reached the other quadrant of the orb, and the sign of Taurus, not far from Cassiopeia [à Caſſiope]. Although it does not seem to us to have burned out even at that time [nec eo tempore deflagraſſe], but on account of the nearness of the Sun (since it was seen only in the morning, at the third hour) obscured, to have vanished from the eyes [obſcuratam ab oculis evanuiſſe]. [Margin: Vbinam fuerit cnrſu concitatior.] *Where it was swifter in its course.* [recte: curſu] It moved much faster around the poles, and at the end of its appearance it did not seem much diminished in size. The tail always toward Spain at the beginning, afterwards more and more toward the western quarter, and finally, in the month of April, most exactly toward the pole of the zodiac, the Sun together with the star of Mars being then placed in a straight line with the body of the comet and the pole of the zodiac. For in this way, withdrawing toward its Receiver and Parent [Suſceptorem atque Parentem], it wished the first and the last time of its birth and death [ortus interitusq; ſui primum tempus ac ultimum] to be hidden. [Margin: Magnitudo Capitis atque Caudæ.] *Size of the head and tail.* Although the most learned man Fabricius [Doctiſſ. Vir Fabritius] wrote that he had observed it small, yet to us its body at first seemed not inferior in size to the star of Jupiter. But the tail occupied about 4° in length. Its colour was Martial [Martius], fading gradually from reddish into pale. Thus Cornelius Gemma, in *Cosmotric.*, book II, chapter 1 [in Coſmotric. Lib. II, cap. 1.].

[Margin: Motus diurnus.] *Daily motion.* According to the observation of the distinguished mathematician Johannes Hommel [Cl. Mathematici Johannis Homelii], this comet sometimes traversed more than 15° of a great circle [circuli majoris] in one day. Tycho [Tych.], book II, page 442.

AD 1557. [Anno Chriſti 1557.]

[Margin: Mira Cometæ facies.] *A strange appearance of the comet.* In AD 1557 [A. C. 1557] a comet in the sign of Sagittarius, in the month of October, having the form of a sword, appeared toward the west while the Sun was in Libra [Sole Libram tenente]. Prætorius. Rockenbach [Rockenbachius]; Camerarius [Camerar.], *de Comet.*, page 1. Herlicius; Eckstorm [Eckſtormius].

But the apparition [ſpecies] that is said to have appeared lately, in the month of October of the previous year (1557), is reported to have been seen in the western quarter and noted in the sign of Sagittarius, while the Sun was traversing Libra. Its form, moreover, was that of a dagger or sword [pugionis ſive enſis], its globe of fire sending out a gleam that tapered to a single point [in unam aciem deſinentem], with a pale colour and a thin and slender light [luce rarâ, atq́ue exili], such as Pliny the Elder wrote that this kind usually is. Camerarius [Camerar,], page 6.

AD 1558. [Anno Chriſti 1558.]

[Margin: Prima & ultima Cometæ apparitio.] *The first and last appearance of the comet.* In AD 1558 [A. C. 1558] a comet appeared in the evening in the sign of Scorpio, showing a pale colour, from the sixth of August to the feast of Bartholomew, stretching its tail toward the west and the north and representing the form of a spit [veru]; it was kindled in Leo, as some will have it, where Mars and Mercury had their course in opposition to Jupiter, etc. The death of the Emperor Charles V follows. Rockenbach [Rockenbachius], Prætorius.

In AD 1558 [A. C. 1558], before the death of Charles, a comet appeared on the Ides of Sextilis [Idibus ſextilibus], toward evening, under the Hair of Berenice [ſub comâ Berenices], with its tail directed toward Spain; moving gradually toward the east, it vanished on the Nones of September [Nonis Septembribus]. Thuanus [Jacques-Auguste de Thou], book 21, page 577; Spondanus [Spondan.], in the Auctuarium [in Auctuario].

Look: the manifest flame of the Pogonias [manifeſta Pogoniæ flamma] appears, in the western quarter [in plagâ occdentis] [recte: occidentis], above Leo, below the sign of Helice [infra Helices Signum], at the Hair of Berenice. Camerarius [Camerar.], page 2.

And of this kind (of the Pogonias) [talis (Pogoniæ)] was also that flame which was lately seen around the Nones of Sextilis [circiter Nonas ſextiles], and which we saw a few days later, rising indeed, and going off toward the south, but by a path still unexplored. Camerarius [Camerar.], page 6.

Tycho mentions it in the *Epistolae Astronomicae* [Epiſtol.], page 144; the Landgrave [Landgravius] and Cornelius Gemma [Cornel. Gemma] observed it. On it, the *Cosmotric.* has the following, in book II, chapter 1 [cap. 1.]: So the haired star [crinitum Sydus] shone around the west in the evening [?], much paler than the one that had preceded it. I first saw its place in 12° of Virgo, in the year 1558, August 17. On the 20th, in the evening, it was 30° 32′ [30° 32] from Arcturus, and 28° 33′ from the end of the tail of the Great Bear; its longitude

was therefore 13° 36′, and its latitude 26° 23′ north [Bor.]. It stood in the west with a very sad and mournful face, that is, of a Saturnine nature, stretching its tail toward the eastern quarter [Orientalcm plagam] [recte: Orientalem]. Nor was it seen for long enough that I could observe its motion; for, as rains came on, it expired before 7 days [ante 7 dies].

[Margin: Obſervatio Principis Haſſiaci.] *Observation of the Prince of Hesse.* In the fifty-eighth year beyond the fifteen-hundredth since salvation was shown to the whole world [Anno poſt exhibitam toti terrarum Orbi ſalutem ſupra mileſimum quingenteſimum, quinquageſimo octavo], a comet appeared which was observed on the 13th day before the Kalends of September [13 Cal. Sept.] by the Most Illustrious Prince and Lord, Lord Wilhelm, Landgrave of Hesse [Dn. Guilhelmo, Landgravio Haſſiæ], with the torquetum [per Torquetum], at about the ninth hour, in 21° of Virgo, removed from the ecliptic by a latitude of 31°, [Margin: Directio Caudæ.] *Direction of the tail.* stretching its hair [Comam] toward the end of the tail of the Great Bear, while it was itself in the asterism of the Hair of Berenice, where the Venerian and Lunar stars [Stellæ Veneriæ & Lunares] are. Then on the 12th day before the Kalends [12 Calend.] it advanced to 23° of Virgo, and in latitude it moved forward either little or not at all. Finally, on the 10th day before the Kalends [10 Calend.], having advanced into 28° of Virgo, into the 35½th degree of latitude. And since it was very faint [obſcurus], it ceased to be observed by the Most Illustrious Prince. He could not easily make out the length of the tail by sight. It is established that the poles of the comet's motion were not far, not far [non procul fuiſſe non procul] from Alrucaba, toward the head of the Great Bear. Rothmann [Rothmannus] testifies, in Tycho's *Epistolae Astronomicae* [inEpiſt. Tychonicis], page 126, that he found these things noted on the frontispiece of the *Ephemerides* of Leovitius [in frontiſpicio Ephemeridum Leovitii] (which the Landgrave [Landgravius] always used to carry with him).

AD 1559. [Anno Chriſti 1559.]

In AD 1559 [A.C. 1559] another comet appeared toward the end of May, until the 22nd day of June, in the east. Riccioli [Ricciol.], book VIII, section 1, *Almagestum* [Almageſt.].

AD 1560. [Anno Chriſti 1560.]

In AD 1560 [A.C. 1560] a comet appeared on the 28th day of the month of December. Thuanus [Thuan.], book 27, page 14. Rockenbach [Rockenbachius].

In AD 1560 [A. C. 1560] a comet was seen in France [In Galliis] for 28 days, in the month of April [Menſe April.]. At Wittenberg [Wittibergæ] Master Philipp Melanchthon [M. Philip. Melanch.] died. Eckstorm [Eckſtormius].

AD 1564. [Anno Chriſti 1564.]

In AD 1564 [A. C. 1564] a comet blazed on the 25th day of July, which is sacred to St James [D. Jacob.]; the Roman Emperor Ferdinand [Ferdinandus Rom.

Imper.] died. Eckstorm [Eckſtormius], from Claudius Grangeus [ex Claudio Grangeo], in the *Commentary on the War of Malta* [in Comment. de bello Melitenſi].

AD 1569. [Anno Chriſti 1569.]

[Margin: Hic Cometa Stationarius tandem factus eſt.] *This comet finally became stationary.* In AD 1569 [A. C. 1569], at Passau and Salzburg in Noricum [Paſſavii ac Salisburgi in Norico], on the 6th day before the Ides of December [6 Id. Decembr.], a comet [Cometes], radiant with a bright colour and burning flames, appeared in the first face of the fifth degree of Capricorn [in prima facie quinti gradus Capricorni], near the bright star of Sagittarius, with its tail turned toward the east, but inclining toward the west. Observed by the mathematician Benedictus Valerius [A Benedicto Valerio Mathematico]. Thuanus [Thuan.], book 44, page 516.

In AD 1569 [A.C. 1569] a comet appeared on the ninth day of November, after sunset, near Jupiter, in 12° of Capricorn; because of the turbulent sky and the stormy weather, its motion could not be observed exactly at that time. Rockenbach [Rockenbachius].

In AD 1569 [A. C. 1569], around the beginning of November, with a very long tail, toward [versùs] Subsolanus, stretched out [Subſolanum extenſa], which, around the 20th day of the same month, was seen a little higher, but shortly afterwards dissolved. Cornelius Gemma.

[Margin: Cometa Stationarius factus.] *The comet became stationary.* Kepler [Keplerus] asserts, in the *Physiology of Comets* [Cometarum Phyſiol.], page 114, that this comet shone in Serpentarius and in the signs of Sagittarius and Capricorn. Moreover, it proceeded out of Cancer, and toward the end, having abandoned its direct course, it turned aside toward 4° of Virgo, where it became stationary [Stationarius evaſit], as Riccioli [Ricciolus] will have it.

AD 1577. [Anno Chriſti 1577.]

[Margin: Mæſtlini obſervatio.] *Mästlin's observation.* Michael Mästlin [Michaël Mæſtlinus] set out the observations of this comet in ten chapters. In them he grants that other comets were below the Moon, but says that this one was above the Moon, [Margin: Directio atque longitudo Caudæ.] *Direction and length of the tail.* and that it threw its tail not exactly into the part opposite the Sun; the tail, he says, was 30° long at the beginning [quam ab initio ait fuiſſe longam 30 grad.]. [Margin: Diſtantia à Terrâ.] *Distance from the Earth.* On the 20th day of November, however, it stood 326 semidiameters of the Earth [Semid. Terr.] from the earth [à terris], with a horizontal parallax of 10′ 30″. [Margin: Prima & ultima apparitio.] *First and last appearance.* But he puts the first appearance on the 12th day of November [in diem 12 Novemb.], and the last on the 10th of January. Tycho, however, compares the places of the fixed stars derived by Mästlin from the Prutenics [ex Prutenicis] with his own, and shows that they sometimes depart from the truth by a whole degree.

Therefore, having corrected them, he derives truer places of the comet from Mästlin's observations, and on that occasion he relates that the comet was first seen at Constantinople on the 10th day of November. Riccioli [Ricciol.], in the *Almagestum* [Almag.], book VIII, section 1, page 13.

[Margin: Quando primùm in Europâ illuxerit.] *When it first shone in Europe.* That famous comet of the year 1577, which likewise set out from the southern regions into the northern hemisphere, although it had scarcely shone on our Europe on the 9th day of November [die vix 9 Novembr.], had nevertheless already been shining in Peru [in Peruviâ] ever since the Kalends of November [à Calendis Novembribus], as the eyewitness Acosta [teſtis eſt oculatus Acoſta] attests, book 3, chapter 8, Govaert Wendelen [Gothofr. Wendelinus], in the *Teratolog. Com.*, page 19.

[Margin: Prima apparitio Cometæ 1577, juxta Corn. Gemmam.] *The first appearance of the comet of 1577, according to Cornelius Gemma [Corn. Gemmam].* This star appeared to us (says Cornelius Gemma, on the appearance and nature of this comet [de Specie Naturâq́; hujus Cometæ]) first on November 14, around the fifth hour, among thin vapours [inter halitus tenues], blazing with a dreadful appearance; [Margin: Species & qualitas.] *Appearance and quality.* the colour of its body itself bright, quite like the purest silver, slightly reddish [leviter ſubrutilantis]; of the size of Venus or Jupiter at the mean longitudes of the epicycle [è longitudinibus mediis Epicycli]: so that at the very first glance many judged it to be a hair fixed to the body of some planet. [Margin: Cauda.] *The tail.* The tail, however, of an almost blood-red colour, from the vapours spread through it, although afterwards, when the air had been cleared, the same, brighter, showed to the eyes a mixture of bronze and lead [æris & plumbi miſcellam]. [Margin: Figura.] *Shape.* It was thrown out rather far into the part opposite the Sun, yet in such a way that, curved, it gradually bent itself toward the line of the winter rising [in ortus hiberni lineam], and toward a place a little higher than the horns of Capricorn. A shape rare indeed, by Hercules [mehercule], and I do not know whether a similar one was ever seen in another: for it rose not with rays broken off straight [radiis in rectum refractis], but with rays tending into an arc, with a neck indeed narrow, set into a small head, but (as we said) a very bright one, and as it were peculiarly circumscribed; widening gradually from there, it extended as far as the length of half a sign: [Margin: Longitudo Caudæ-] *Length of the tail.* although its brightness, or its utmost weakening [vel enervatio ſumma], easily reached to the twentieth degree, especially around the beginning of December. [Margin: Latitudo.] *Width.* The greatest width of the tail bounded by scarcely five degrees [vix quinque gradibus definita]. [Margin: Situs.] *Position.* The position of the whole comet was seen, in our region at least and in France, in such a way that the head toward Spain, the curvature of the tail toward Italy and the lands lying toward Subsolanus [contra terrasq́; ad Subſolanum ſitas], was bent very slightly. [Margin: Fulgoris differentia per partes.] *Difference of brightness by parts.* Finally,

it was remarkable for its brightness, and the reflection of the rays dense toward the north, gradually darker and thinner, and more mournful, toward the south.

[Margin: Singulare Caudæ phænomenum.] *A singular phenomenon of the tail.* The species of its shape, of the Ceratiae [Figuræ ſpecies ceratiarum], of the kind that in Alkindus [Alkindum] generally found the name soldier [militis nomen], although it may more correctly be called the Hippeus of the Greeks [Hippeus Græcorum], because a certain continuous projection stood out from it, like a second tail, downward, obliquely or toward Euroafricus [Euroafricum], while the rest of its radiance displayed most excellently a very broad Corus [Corum latisſimum], or a peacock's tail, or the image of a soldier's plume. Above all, however, you have to note a singular phenomenon of the tail, which Cornelius Gemma [Corn. Gemma] observed carefully in this comet on November 28 [28 Novemb.]. For then (he says) a branch, as of a second tail, clearly flowed downward from the neck and head, persisting thus for very many days, until the whole mass burned out, either gradually dispersed or withering. It stood, therefore, bearing the likeness of a wing now fully spread; the end of the aponeurosis [aponeuroſeos] had reached beyond the nostrils of Pegasus. Again, on December 3 [Die rursùs 3 Decembr.], around the eighth hour, something rare, and to be wondered at above all others, was added to this portentous torch. For to many who were then observing more attentively it seemed, suddenly gaping open, to brandish three huge rays like fiery spears, gradually, toward the Mediterranean sea [ad mediterraneum fretum]; and men worthy of belief steadfastly assert that, the first shaft hurled, it made straight for Italy, secondly for the Herculean shore [littus Herculeum], lastly for the western quarter: the first (I say) with its line running out at oblique angles, the second as if along the perpendicular, the third crosswise and as it were at right angles. No effluvia worth speaking of [nulla effata digna] are reported as observed toward the north, or the upper parts. As is plainly evident from the picture of this comet on page 452, book VIII, of this *Cometogr.* [pag.452, Lib.VIII hujus Cometogr.].

[Margin: Ordo motus atq́; proportio.] *Order and proportion of the motion.* For the rest, it deserves to be noted no less that the line of its motion, which thereafter flowed almost straight in a continuous course, reached from 0° [?] of Capricorn, through the contact of the equator and of the meridian line passing through the pole of the zodiac, between Equiculus [Equiculum] and Delphinus [Delphina], as far as the breast of Pegasus itself, with this proportion kept: that the motion and the vigour of the light, greatest at the beginning, diminished step by step, as is clearly demonstrated from the doctrine of triangles and by the distances of the fixed stars.

[Margin: Locus primæ apparitionis.] *Place of the first appearance.* This, then, is the summary account of its whole place and motion. It first appeared around the beginning of Capricorn, very near Saturn; but from there, when it had climbed a little, it followed the straight line of the wind Libonotus [Venti Libonoti] and, up to the last point of its duration, turned aside from it by scarcely a straw's breadth (so to speak) [vix latum (ut ſic loquar) culmum], with

the proportion kept that it traversed most swiftly, and in one day, a longitude of about 5°, but that, as it advanced, the speed of its motion gradually diminished together with the vigour of its light; although the size of its form was perhaps believed, from the condition of the air, to be greater now and then around the Ides of December [circa Idus Decembricas], at which time, as around the middle of its whole course, it scarcely completed a space of one degree and a half; [Margin: Stationarius factus eſt.] *It became stationary.* so that at last scarcely 15′, and indeed, around the middle of January 1578 [circa medium Jan. 1578], it seemed almost stationary. It passed swiftly through the two signs of Saturn, Capricorn and Aquarius; growing faint at the borders of the latter [cujus in finibus], it nevertheless reached, at a very slow pace, the middle of the sign of Pisces, and not far from the Tropic of Cancer, fixed at the twin little stars in the breast of Pegasus, it expired completely; and this, I think, is not without a certain mystery, or hieroglyphic mark. [Margin: Via Cometæ itineraria.] *The comet's route of travel.* The line of the whole course [Ductus totius linea], again, from the arrow of Sagittarius (and that not without a certain divine will [neque id ſine numine certo]) into its head to the topmost crown, through the flanks and hands of Antinous (which is the Zodomitic [Zodomiticum] sign), through the contact of the equinoctial and of the meridian circle passing through the pole, between Delphinus and the Lesser Horse [Equum minorem], as far as the constellation of Pegasus, as if it had directed its course toward the head and chains of the wretched Andromeda. [Margin: Declinatio ſumma.] *Greatest declination.* Indeed, although the sight of the eyes by no means reached its last appearance, I nevertheless think, and am led by sure reasons to believe, that it passed from one of the tropic circles to the other. Hence its greatest declination, too, was once to the south and once to the north, the same as the greatest declination of the Sun, 23½°. [Margin: Duratio.] *Duration.* Its whole duration easily filled three periods of the Moon in all. [Margin: Diſtantia Cometæ à Terrâ.] *Distance of the comet from the Earth.* [Margin: Parallaxis.] *Parallax.* Its distance from the Earth was determined by Cornelius Gemma to be greater than that of the Moon itself, since its horizontal parallax was no more than 40′. [Margin: Cometæ locus concluditur fuiſſe in orbe Mercurii.] *The place of the comet is concluded to have been in the orb of Mercury.* So that (in his opinion) it stood in the orb of Mercury, whose appearance and brightness, and also its inequality of motion, it observed, if not exactly, at least in closer traces. Although, however, it had received a very great deal of the Saturnine nature, and something also from Jupiter and Mars, etc. On the proportion of its size to the Earth itself I determine nothing, since its body far exceeds the star of Mercury. The tail, extended (as has been said) over more than half a sign, surpasses the size of the Earth in an inexpressible proportion. These are the things that Cornelius Gemma, a most learned man, recorded in a certain little work on the prodigious [prodiosâ] [recte: prodigiosâ] appearance and nature of this comet of 1577, chapter 11.

Now let us see what Tycho Brahe, the prince of astronomers, who measured it more accurately than all others, noted about this comet in his work on the ethereal phenomena of the world.

[Margin: Obſervatio Tychonis Brahæi.] *Tycho Brahe's observation.* In the course of the year 1577 from the birth of Christ (he says), around the tenth day of the month of November, a certain unusual star, pouring out long hair, showed itself near the setting part of the sky; [Margin: Figura atque color capitis.] *Shape and colour of the head.* its body was round, bright, and conspicuous with a certain somewhat leaden whiteness. [Margin: Cometa ortum versùs caudam expoſuit.] *The comet set out its tail toward the east.* The tail, however, which stretched mostly toward the east, as if into the parts opposite the Sun, blazed with rather reddish rays, and these were the denser and the more apparent the nearer they were to the head; around the extremity, however, they were sparser and conveyed less light and colour to the eyes. [Margin: Et quidem ex parte incurvatam.] *And indeed curved in part.* Moreover, the tail itself was somewhat curved, so that it turned its convex side toward the zenith and its concave side toward the horizon.

[Margin: Cometæ ſitus, curſusq;.] *Position and course of the comet.* On the day on which this haired star first shone for us, as soon as the darkness of night was bringing the other stars before the eyes, it seemed to be placed just above the head of the starry Sagittarius, not far from Saturn, than which it was a little higher; and it stretched its tail toward the horns of Capricorn. Then, in the following days, it proceeded with a swifter motion from this star of Sagittarius to the constellation of Antinous, and passed beside its left hand; and from there, having gone past the Tail of Delphinus, it seemed to pass through the nostrils of Equuleus, leaving the Head of Pegasus somewhat to the south. From there it was carried straight toward the star in the right shoulder of Pegasus (which is called Scheat), though with a slower motion than before; [Margin: Quo loco & tempore diſparuerit.] *Where and when it disappeared.* and at last, in the space that lies midway between the star named in the shoulder and the two very small stars in the breast of Pegasus, it disappeared from us, and that after January 26 of the year 1578.

[Margin: Capitis & Caudæ magnitudo.] *Size of the head and tail.* On November 13, the day on which the comet was first observed by Tycho, the diameter of the head was found to be 7′.

The length of the tail [Caudæ longitudo], which [quæ] up to [usq;] the horn of Capricorn extended, was about 22°, although its extremity itself, because of its thinness, did not lie open to precise observation, so that for that reason it is reasonable that it was a little longer than it appeared. [Margin: Cauda in extremitate latior.] *The tail broader at its extremity.* It was, moreover, bent like an arc, as I said above, and broader at the end, and a little wider than around its middle.

[Margin: Capitis caudæq; color die 23 Novembr.] *Colour of the head and tail on November 23.* On November 23 the colour of the comet's head was white,

not so bright but paler, and not as shining as the light of the stars. The tail, however, showed a dark redness, especially where it was nearer the head, such as some flame struggling out through dense smoke generally has (which I think happened on account of the intervening air near the horizon); but just as the tail itself became progressively thinner toward the end, so too this colour appeared less clearly there.

[Margin: Diametri Cometæ vera magnitudo, Caudæq; longitudo vera.] *The true size of the comet's diameter, and the true length of the tail.* Tycho, p. 202, found the true diameter of the comet to have been 368 German miles, so that the ratio of the comet's diameter to the Earth's is as 3 to 14, and to the Moon's diameter as 3 to 4. The length of the tail, however, the author found to be 96 semidiameters of the Earth. [Margin: Directio Caudæ.] *Direction of the tail.* As for the extension of the tail, Tycho for his part at first persuaded himself that it stretched toward the star of Venus; but afterwards, having examined the matter better, he himself freely acknowledged that it went off rather toward the parts opposite the Sun (as has also been demonstrated more fully by us in Book VIII, p. 488), [Margin: Deviatio Caudæ.] *Deviation of the tail.* although with a notable deviation toward the south, namely at an angle of 15°, 20° and more degrees; and indeed one continually variable, as can likewise be seen in the place cited in Tycho, p. 179.

[Margin: Cometa directus.] *The comet direct.* As to its apparent motion, *this comet was always direct*. At the beginning, on November 10, it stood at 24° 29′ of Sagittarius; from there it advanced through Capricorn, Aquarius, as far as 20° 55′ of Pisces, the place where it was found on January 26 of the year 1578. At the beginning it showed a latitude of 2°, but at the last 29° 15′. [Margin: Angulus Orbitæ fuit variabilis,ut ut Tycho alit[[e/o]]r ſenſerit.] *The angle of the orbit was variable, although Tycho thought otherwise.* The angle of the orbit and the ecliptic, with the node standing at about 20° 35′ of Aquarius, was 29° 10′ at the beginning; it was nevertheless variable, contrary to the opinion of Tycho, as has been demonstrated by us on p. 115 of Book I of the *Cometegr.* For it increased gradually, and so likewise did the angle of the orbit and the equator, which Tycho determined to be 33° 46′.

[Margin: Cometa non abſolutè ſub circulo incesſit maximo.] *The comet did not advance under an absolutely great circle.* This comet therefore described, according to Tycho, an exactly great circle in the sphere (but in my opinion not altogether a great one, as we have proved in its place), contained midway between its poles, and at no point in the whole time of its duration did it deviate from this circle to one side or the other. [Margin: Motus in proprio Tramite fuit inæqualis.] *The motion in its own path was unequal.* Moreover, under this circle it kept an ordinary motion, but not a steady one: rather, one slackening progressively and step by step, as usually happens in the wandering stars. This very motion it never showed faster than the slowest daily motion of the Moon, but indeed far slower; and finally it bounded the places of the beginning and end of its motion within each of the tropics, near the limits of

the Sun's digression, and in this way completed a quadrant of the sphere. Its daily motion at the outset, namely on November 10, was 5° 24′; in the month of December about 1°; and on January 16 only 16′.

[Margin: Cometa in æthere omninò ſedem ſuam habuit.] *The comet had its seat entirely in the aether.* Finally, Tycho demonstrated more than sufficiently that this comet was entirely ethereal and rejected (as he puts it on p. 157) every perceptible quantity of parallax.

For the horizontal parallax [Diverſitas enim adſpectus horizontalis] was not found to be anything except [non … niſi] 19′ 12″, namely on November 10; and because it diminished from day to day as far as 2′, it is clearly evident that the comet continually moved off to more remote regions. [Margin: Parallaxis atque Diſtantia ejus à Terrâ.] *Its parallax and distance from the Earth.* For at the beginning it was only 173 semidiameters of the Earth away from us, but at the last 1733, namely according to Tycho's distance of the Sun from the Earth. According to our calculation, however, this comet was at first removed from the Earth by 2365 semidiameters of the Earth, but then by 10,300 semidiameters of the Earth, that is, almost twice as far as the Sun itself at its mean distance. [Margin: Situs Trajectoriæ.] *Position of the path.* And hence, with its true motion in the path (which it drew within the annual orbit to 26° 15′ of Virgo, at an angle of obliquity of 51° 53′, as can be seen in Book IX, p. 617), it traversed 118 semidiameters of the Earth at the beginning and 103 at the end; [Margin: Motus verus quotidiè ſegnior eſt factus.] *The true motion became slower every day.* from which it is manifest that this true motion was gradually and continually slowed. Lastly, on the tail and the head he adds the following in Book I of the *Epiſtolae Aſtronomicae* [Lib. I Epiſt. Aſtron.], p. 143: [Margin: Accurata Caudæ Deſcriptio.] *An exact description of the tail.* The tail, especially at the beginning, was very remarkable, extremely rare and like thin rays, so much so that certain stars which it was passing by shone through it several times. Nor was it of the same colour as the head; rather, it changed this colour from time to time, which, however, I think happened because of the differing quality of the intervening air, especially near the horizon. [Margin: Caput erat ſolidè compactum.] *The head was solidly compacted.* But the head itself, too, was solidly compacted and much brighter than the tail, and it was seen to be exactly round, so much so that at the beginning you would have called it a little Moon. The hairs themselves, too, were joined to the head in a point, and afterwards spread out in breadth and length. From this it was easy to gather that the tail was produced by the penetration of some external light, in whatever way this happened and from wherever it came. And these are the things from the Tychonic observations made at Uraniborg [Uranoburgi] that it seemed good to bring before the public. I could indeed also add some things to these from very many other authors, but I considered it altogether superfluous. [Margin: Quinam præ cæteris hunc Cometam ſedulò rimati ſint.] *Who, above the rest, examined this comet diligently.* Since, as far as I know, no one besides Tycho, Mästlin and Cornelius Gemma observed this comet more precisely and measured it with more exact and larger

instruments. If you desire a genuine likeness of this haired star, kind reader, we have already shown it, exactly drawn, in Book VIII, p. 452.

In AD 1578 [A. C. 1578], on May 16, at 9^h after sunset, at which time Jupiter and the Moon were in conjunction in Libra, a comet was seen toward the east and the south, having a long tail and stretching it toward the north. Two other, smaller comets followed it; opposite them fiery torches appeared, and suddenly vanished. On the effect of this comet, see Ælis. Rosler. in the ninth Theory [Vid. Æliſ. Rosler. in nonâ Theoria]. Rockenbach. Cramerus from Büntingus [ex Buntingo].

[Margin: Obſervatio Rivandri Cometæ 1580.] *Rivander's observation of the comet of 1580.* In AD 1580 [A. C. 1580], on October 9, a very small comet was first seen around the vernal equinox, gradually turning aside toward the south; with a retrograde motion it ran through the signs of Pisces, Aquarius, Capricorn, Sagittarius. Then, having become northern by its ascent, with a very swift motion toward the flying Eagle [Aquilam volantem] in the sign of Capricorn and Sagittarius it attained its greatest northern latitude; from there, directing its motion toward Serpentarius, it was stationary from November 21 until the last day of that month. Around the beginning of Sagittarius, however, it suddenly changed its motion and, descending toward the south, became direct.

And when it had again reached the Zodiac, in the first degree of Sagittarius [Cumque rurſus … in primo Gradu Sagittarii], historians write that it vanished at the beginning of the following year. Rockenbach, Cramerus from Rivander's special treatise.

Tycho mentions this comet, *Epistolae Astronomicae*, p. 143. Eckstorm, indeed, seems to assign this comet to the year 1578, but wrongly.

[Margin: Ejusdem Cometæ Obſervatio Theodori Graminæi.] *Observation of the same comet by Theodorus Graminæus.* On October 11 of the year 1580, around the seventh hour of the evening, a comet was seen at the castle of Horstmar [arce Horſtmarianâ] in the bishopric of Münster [Epiſcopatûs Monaſterienſis]. [Margin: Cometæ Situs.] *Position of the comet.* Its position, as far as it could be noted roughly [platicè], without instruments and an astronomical globe, by sight alone, was seen around the seventh or eighth degree of Pisces, beyond the equator, near the Urn of Aquarius, among the stars of the water poured out of the Urn; and it stretched out a somewhat dark and leaden tail, of the nature of Saturn, toward the equinoctial east. [Margin: Color.] *Colour.* The fire and glow of the comet, and also the leaden colour of the tail, could be judged to be of the nature of Saturn himself. As to the rarity of its matter, however, apart from the comet's being noticed to be of a white colour, its effect too could be judged from this to be neither great nor lasting.

[Margin: Motus.] *Motion.* As for the motion of the comet, it moved off from the Urn of Aquarius, through the head of Pegasus, the winged Horse, through Delphinus, between Sagitta and Aquila, so far that on November 14 it formed with the stars of the first magnitude of Orpheus's Lyre and of Aquila an

isosceles triangle not much different from an equilateral one; and, advancing in a straight line between west and north, around the Nativity of the Lord, under the figure of Ophiuchus or Serpentarius, it ceased to appear and to be seen. So that, with respect to its first seat, in which it was seen around October 11, it advanced from Pisces through Aquarius and Capricorn as far as into Sagittarius. Theodorus Graminæus.

AD 1580. [Anno Chriſti 1580.]

[Margin: ThaddæiHagecii Obſervatio Cometæ 1580.] *Tadeáš Hájek's observation of the comet of 1580.* The comet first shone forth at Prague on October 10, under the head of the preceding Fish, between the zodiac and the equator, at about 5° of Pisces. To me, however, it first became known on the 12th of the same month. [Margin: Facies,ejusq́; color.] *Its appearance and its colour.* It was of a very gloomy and mournful countenance, namely of a Saturnine nature, dark and bright [obſcurus & lucidus]; and as if surpassing in size, as far as sight goes, the stars of the first magnitude. [Margin: Omni caudâ exutus.] *Stripped of all tail.* It was seen to be without a tail, nor did any curls appear around it such that it could have been called either a haired star or a Pogonias; and it was seen in this form in those first days of its appearance. [Margin: Tenue quoddam jubar Ortum versùs projecit.] *It cast a certain faint radiance toward the east.* At the first sight of it, indeed, certain rays, or a certain light, or an outflow, very slight, thin and rare, and scarcely perceptible to the senses, seemed to be scattered into the part turned away from the Sun, straight toward the east. But for those looking at it more intently, that ray was taken away from view, and only the body of the comet was seen, dark, gloomy, bright, and like some knot; differing from the other stars by its murkiness alone and by its rapid progress from east to west: so that I wonder it could be distinguished by the unskilled, etc.

[Margin: Cometa fuit Retrogradus.] *The comet was retrograde.* In such a form it was seen for about 14 days and more, creeping from the first parts of the dodecatemory of Pisces obliquely toward the west, against the order of the signs: first through the equator, behind the stars in the right hand of Aquarius, to the head of Pegasus and its bright star, which was the upper one in it. [Margin: Motus apparens.] *Apparent motion.* From there it was carried through Equiculus and Delphinus with a fairly rapid course. For in the space of one natural day it completed 4°, more or less.

Toward the end of October [Sub finem Octobri] and the beginning of November, with the sky very clear, it appeared much brighter than on the preceding days. The tail, or outflow [defluvium], then appeared more conspicuous and more prominent: always turned away from the Sun into the eastern quarter, slight, thin and rare; one would sooner have called it a fine smoke than a ray. [Margin: Motus langueſcit.] *The motion slackens.* From then on its course gradually slackened, while it was carried between the right wing of Aquila and Sagitta, through the Milky Way [Galaxiam] and its other branch [alterum divertigium], until November 14.

[Margin: Motus initiò fuit velocior.] *At the beginning the motion was faster.* It should be noted at this point, and concerning this comet, that just as from the beginning of its rising it was carried against the Sun in the first days with a fairly rapid and even course, as if about to meet it, until October 21, so in turn from then on it was found gradually to check its course, until November 14. [Margin: Cauda in oppoſitum planè Solis vergebat.] *The tail inclined directly opposite the Sun.* Throughout that time it cast that light of its own, or outflow, into the part turned away from the Sun. Accordingly, advancing more slowly than the Sun, from the 14th it began to become at once an evening and a morning comet [veſpertinus ſimul & matutinus], although, because of the inclemency of the sky, it was not always visible either in the evening or in the morning. It kept this state until about December 6, from which time it was at least a morning comet; [Margin: Caudam primùm Ortum, poſteà Boream versùs projecit.] *It cast its tail first toward the east, afterwards toward the north.* and it was stretching its tail no longer toward the east, as before, but toward the north: namely in accordance with the comet's different position relative to the Sun, so that the tail was always turned into the part turned away from the Sun, as has already been observed in very many comets. The common people thought that a new comet had shone forth; I removed this error from the minds of many. The common people were once held by the same error, as Apian [Appianus] noted on the comet of the year 1531. For since it was seen in the morning and in the evening, they judged this one to be different from that one. And it is credible that many of those who have recorded histories of comets for us were deceived in similar cases, such as Matthæus Palmerius, etc.

[Margin: Hagecius exiſtimat Cometam incesſisſe motu irregulari; ſed decipitur.] *Hájek thinks the comet advanced with an irregular motion, but he is mistaken.* From what has been said (the author adds, but he set down his calculation wrongly, as you will soon perceive) it can easily be understood how anomalous and disordered a motion this comet had. [Margin: Curſus Cometæ.] *Course of the comet.* For from the first day it was sighted it was carried obliquely with a swift course toward the Tropic of Cancer, completing 4° on each day. When it was at its highest elevation [in ſummâ ſuâ evectione], and as it were in a kind of apogee of its own, near the Tropic of Cancer, there, just as the Sun does around the solstices, it seemed to stand still, or at least to advance at a slow pace [lentu gradu] [recte: lento gradu]; this was around November 14. From there, gradually bending its path, as the Sun does from the summer solstice toward the south, it advanced slowly until the 24th of the same month. Then again, with a somewhat more intense and more perceptible course, it turned toward the south, describing a kind of arc, as far as the place of the equator, where we have said it stood on the last day. If we weigh all these things, we shall clearly recognize that the motion of this comet was not only anomalous but also disordered: that it did not describe the circuit of a great circle, but strayed here and there in a roving course, like the wandering stars. If we now consider, according to that anomalous and disordered course, the time of its

whole duration, from the beginning of its rising until its dispersal, and divide it into two parts: the first of them, with the count beginning from October 4, when it first began to become visible to some, until about November 14, when it seemed to stand still at its highest elevation; then in this one we shall count 40 days but the second [altera autem], that is, from the 14th day of November [hoc eſt, à die 14 Novembr.] until December 16, will contain 32 days. [Margin: Quo tempore Cometa diſparuerit.] *When the comet disappeared.* But we said a little before that on December 16 it could still be seen well; nor is it likely that it disappeared on the next day, but rather that it vanished on some day between that day and the sacred day of the Nativity of our Lord and Saviour. For on that sacred day itself, when the sky was clear enough, it appeared nowhere. [Margin: Tempus durationis Cometæ 1580.] *Duration of the comet of 1580.* It was therefore dissolved between December 16 and 25, that is, around the 20th day of the same month; on this reckoning the second part of the duration will have 36, but the whole time 76 days. We made this division of the time while the comet was shining, and it was by no idle conjecture that we grasped the time of its dissolution. If the middle time of the comet, when it either reached its highest peak or made the first change in its motion, could have been known, and the obscurity of the sky had not prevented it, a more correct pronouncement could also, I think, have been made about its end.

[Margin: Diſtantia Cometæ à terrâ.] *Distance of the comet from the Earth.* As for the rest, from the investigation of the parallax, the Hájek named above determined that the distance of this comet from the Earth was 157 semidiameters of the Earth [Semid.Terræ], and that it had its dwelling [domicilium] in the orb of Mercury and on the border of Venus.

These, in my opinion, are more or less the chief points that I wished to draw from the observations of Tadeáš Hájek and from his *Physical and Mathematical Demonstration on Comets* [Apodixi Phyſicâ & Mathematicâ de Cometis]; if you want more detailed observations, read that little work, published at Görlitz [Gorlicii] in 1581.

[Margin: Hagecius circa motum aberravit.] *Hájek went astray about the motion.* But I would like you to note, kind reader, that this author (if I may say so with the leave of so great a man) departed constantly from the truth, since he holds that the motion of this comet was not only anomalous but also disordered, and that it in no way described the circuit of a great circle, but strayed here and there in a roving course like the wandering stars. [Margin: Ex Mæſtlini obſervationibus contrarium patet.] *From Mästlin's observations the contrary is evident.* For not only is the contrary quite clear from Mästlin's observations, but, I beg you, if you will, mark those places of all the days by longitude and latitude on an artificial globe, as I myself did: you will find that this comet, like the other comets, kept quite precisely the track of a great circle [ductum circuli maximum], especially in the middle of its path. [Margin: Satis accuratè ſectionem circuli maximi deſcripſit.] *It described the section of a great circle quite accurately.* At the beginning, it is true, and at the end, it deviated in part from that

straight path; but this is common to all comets that wander over a wide space of the sky, of many signs, as has also been clearly demonstrated by us in its place for the comet of 1664 and others. Moreover, the Hájek named refutes himself with his very own words, when he says that the comet strayed here and there in a roving course like the wandering stars. [Margin: Hagecii argumentum invalidum eſt.] *Hájek's argument is invalid.* Whereas it is nevertheless most certain, and hidden from no one even slightly versed in astronomical matters, that all the planets proceed with a supremely regular and most ordered motion, even if they deviate somewhat from the straight path of a great circle under a certain inclination, and at fixed times are seen direct, stationary and retrograde. But all this will become clearer from the following observation of the most distinguished Michael Mästlin, by no means the last among mathematicians.

[Margin: Michaëlis Mæſtlini obſervatio Cometæ 1580.] *Michael Mästlin's observation of the comet of 1580.* On what day this comet first rose (says Mästlin) I do not know. For although, as usual, I am in the habit of being frequently intent on viewing the stars of the sky, especially while I observe the places, motions, distances and meridian altitudes of the stars, both fixed and wandering, with the help of the large quadrant and the longer astronomical staff [Baculi Aſtronomici], so that at some time, God helping [ut aliquando, Deo adjuvante], I may restore to soundness the calculation of the tables [?], which has collapsed in the motions, I nevertheless remember that from August onward I never looked with particular attention at the sign and the stars of Cetus, near which I first saw the comet, nor yet at the hind stars of Eridanus, from which it perhaps rose. [Margin: Cometa 2 Octobr. juxta Stellas Ceti.] *The comet on October 2 near the stars of Cetus.* But on October 2, when by pure chance [fortè fortuitò] I was looking at the stars that are the fifteenth and sixteenth in the asterism of Cetus, I noticed, greatly dismayed in mind, the star of a comet joined to them. [Margin: Motus Cometæ retrogradus.] *Retrograde motion of the comet.* From that place, on the following days, it climbed against the order of the signs through 4 unformed stars of Pisces, below the asterism of the following Fish; [Margin: Via obliqua & poſtremò incurvata.] *The path oblique, and at last curved.* and, leaving the hand of Aquarius to the south but the head and the muzzle of Pegasus [muſcidam Pegaſi] to the north, it passed through the stars in the nostrils of Equiculus, the eastern of them inclined to the north and the western to the south. At that place it crossed the path of the comet of 1577, which, approaching there from Sagittarius through Antinous, passed through (although it is held by some to have been much more northerly, whereas nevertheless on December 2 and 3 of the year 1577 everyone saw by plain experience how exactly it passed through the middle of them). [Margin: Curſus Cometæ.] *Course of the comet.* Afterwards this comet, proceeding through Delphinus, was with its head not much more southerly than the point of Sagitta; indeed, in that passage it covered all its stars with its tail. From there it crossed Aquila. But afterwards, when it had passed the colure of the solstices [Solſtitiorum Colurum], it turned its motion back toward the head of Hercules or Engonasin [Herculis ſeu Engonaſin caput],

through the shoulder of Ophiuchus and the left side, as if it were about to descend to Scorpio. [Margin: Quot Signa cæleſtia pervagaverit?] *How many celestial signs did it traverse?* In the time during which it was observed by me, it ran through 4 signs of the zodiac and about a half, namely the first part of Aries, Pisces, Aquarius, Capricorn, and almost the whole of Sagittarius. [Margin: Quo loco celerrimus extiterit Cometa?] *In what place was the comet fastest?* It was slow at the beginning; from then on it gradually advanced with a faster motion, and was fastest around the beginning of Pisces, where in one day it covered more than 5°. [Margin: Curſum reduxit factusq́; eſt directus.] *It turned back its course and became direct.* But afterwards it slackened again, until at last, turning toward the equator, near the end it seemed to have wholly held back its motion in longitude, as one that had so far been retrograde and wished henceforth to be direct; its latitude, however, or northern declination, it diminished more and more every day.

[Margin: Cometa quanquam valdè obſcurus, major tamen Venere extitit.] *The comet, though very dim, was nevertheless larger than Venus.* On October 2, when it was first seen by me, it lacked any tail, having a round shape surrounded all round with hairs [capicillis]. It far exceeded Venus in size, but in the brightness of its light it could in no way be compared. For it shone with a very dull and dark, or blackish, colour, not unlike a dim and nebulous star. On October 8 it began to be a little brighter and somewhat whitish, but still without a tail. [Margin: Cometa die 9 Octobr. demum caudatus factus.] *The comet became tailed only on October 9.* Only on that day, I hear, did its presence become known to many people here and there. On the following day a somewhat dim whiteness, marking its hair or tail, began to shine forth. On that day, therefore, it first revealed itself to be a comate star [Comatam Stellam], or, if you prefer, a Pogonias [Pogoniam]. [Margin: Longitudo Caudæ.] *Length of the tail.* The length of the tail did not appear equal to that of the one we saw three years before. On October 10 it seemed to equal 4½°, or even to exceed it. But on the following days, when I observed its length in the absence of the Moon, both I and the others who were with me, at least those who looked with sight that was not dull, noticed that the length of the tail, if not greater, was nevertheless certainly not much shorter than that of the one we saw with great horror in the year 1577; for rays came out of the head in a long train, stretching themselves beyond a dodecatemory [ultra dodecatemorion ſe ſe extendentes]. They were, however, very dim and dark, so much so that (which is not unworthy of wonder) they could be observed only by those looking at them obliquely, but not by those gazing at them directly. From this we were able to infer that, if the brightness of its splendour had corresponded to its size, it would by no means have lain hidden and unknown for so long. [Margin: Cometa non omninò Soli adverſam habuit caudam.] *The comet did not have its tail facing wholly away from the Sun.* It had its tail facing away from the Sun [Soli adverſam], as has been common to all comets observed so far, although not exactly diametrically opposite. Hence I could easily be persuaded that this tail

did not first grow on it on the 9th, although we who live on the earth could not see the least thing of it, since it raised it straight up into the sky. For the Sun and the comet were in opposite places of the zodiac; but as it withdrew from the Sun's diameter [à Solis diametro], it began to turn it more and more toward our view. At first this comet rose after sunset, and went below the horizon again in the morning before twilight. But when the tail was added to it, it rose above the eastern horizon [horizontem ortivum] before sunset, but set at the very beginning of the morning [mane ſummo], a little after the third hour of the morning. The tail faced the equinoctial east. But the higher it climbed toward the north, the more it bent its tail toward the north, until at last it was carried toward the pole in both the evening and the morning hours.

[Margin: Magnitudo Diametri apparentis.] *Size of the apparent diameter.* About the head itself it must be added that the author observed its diameter, together with its hair, on October 15 as 16′ 30″. [Margin: Parallaxis fuit imperceptibilis.] *The parallax was imperceptible.* But that this comet had no parallax perceptible to the senses, and so was raised far above the elementary sphere, can be seen on p. 18, chapter 3. Moreover, he says, in this same comet, as also in the earlier one, it can be seen by evident conjecture and certain demonstration that it likewise was granted no place among the elementary spheres, but in the high aether. [Margin: Cometa fuit in æthere.] *The comet was in the aether.* For although its whole motion appeared anomalous, it was nevertheless itself a witness to its own supreme regularity, on which it depended. [Margin: Regularisſimum motum exercuit.] *It performed a most regular motion.* Indeed, if you look at the motion in longitude, it gradually increased, and gradually likewise, with a fixed proportion kept on both sides, it became slacker, until at last it was judged to have wanted to become stationary. If you look at the latitude (for it did not advance with a simple motion in longitude, like the Sun, or even the Moon, but added to it a wandering in latitude, like the other planets), it was found to behave in the same way. But whether so discordant a concord can be proper to elementary matter burning in the air, so that it does not wander with an indeterminate motion and place, and roam about with no proportion kept, or certainly not so constant a one, I very much doubt. Chapter V, p. 31.

[Margin: Cometæ mora in Signis.] *The comet's stay in the signs.* Finally, in chapter 4, p. 28, he adds: In this comet we saw not a few things worthy of wonder. For the first four days on which it was observed by me, it stayed in Aries (no doubt longer, if indeed it shone forth on the days before October 2); in the 7 following days it measured out the whole sign of Pisces. In Aquarius it lingered only 8 days, but in traversing Capricorn it spent 14 days; for the remaining 38 days, which were left up to the last day of my observation, it stayed in Sagittarius, and no doubt made longer stays, until it came to its beginning, or the end of Scorpio, unless indeed it turned its motion back into the opposite direction, to advance according to the order of the signs, before it reached Scorpio.

[Margin: Velocitas & tarditas Cometa ubi?] *Where the speed and the slowness of the comet?* Its motion at the beginning and end of the apparition (I am speaking, however, of the days on which it was seen by me; for of the others, before and after, I can assert nothing) was slow, though slower at the end; but it was fastest when it was a third of a circle [triente circuli] away from the Sun, namely around October 13, when the comet was at the beginning of Pisces and the Sun at the beginning of Scorpio. For in those days it completed in its circle a full 5°, with some minutes [cum aliquot ſcrupulis].

[Margin: Cometa retrogradus, factus eſt Stationarius.] *The comet, being retrograde, became stationary.* Throughout that whole time, namely for 71 days, from October 2 until December 12, it was retrograde; at the end, however, it seemed as it were entirely stationary (as far as the motion in longitude is concerned). In a similar way the comet of the year 1577 advanced direct throughout the time of its apparition, but at the last came to rest motionless, without doubt about to become retrograde if it had had to remain longer.

Just as the comet of the year 1577, imitating the Sun, which never departs from the rule of its circle, the ecliptic line, did not stray [exorbitavit] from the periphery of its circle by even a finger's breadth [nullo vel lato digito]: [Margin: Cometa leges Planetarum ſecutus eſt.] *The comet followed the laws of the planets.* so this one followed the laws of the five wandering stars [Stellarum quinq́ue errantium]. For just as those, before and after their retrogradations, do not return by the former path by which they had come, since the motion in latitude, which mixes itself in, leads them aside elsewhere: so this comet, when about to approach its station, is drawn away a long distance toward the south by the motion of its latitude. Indeed, the latitude is so entangled with the whole motion in longitude that it will be clear that it could not have had its path in any certain and definite circle, but that it always bent its longitude [nunquam non detorſiſſe] according to the measure of its latitude. And let it suffice to have noted these things from the observations of the most distinguished Michael Mästlin made on this comet.

[Margin: Obſervatio Cometæ 1580 Matthiæ Meine Dantiſcani.] *Observation of the comet of 1580 by Matthias Meine of Danzig.* After Mästlin and Hájek, Master [M.] Matthias Meine of Danzig, at that time professor at the Academy of Königsberg [Academiæ Regiomontanæ], also observed this comet quite accurately, above others [præ aliis]; and indeed from October 13 or 16 to January 11 or 14 of the following year, so that it was seen for three months. More particular details will be clear from the little work [Opuſculo] of the same author published on this comet.

[Margin: Cometa 1582 celerrimo motu Septentrionem versùs progreſſus eſt.] *The comet of 1582 advanced toward the north with a very swift motion.* In AD 1582 [A. C. 1582], a comet of immense size (although it was noted by few) appeared on May 14 after sunset, coming forth from the Sun between west and north, and ascending with a very swift motion toward the north, casting its tail between the right and the left shoulder of Auriga, ascending toward the Sun;

and on the eighteenth day of May of the same year it vanished. Rockenbach. Cramerus from Herlicius [ex Herlicio]. Tycho mentions this comet in the *Epistolae Astronomicae*, p. 143.

In AD 1582 [A. C. 1582], on May 14, a horrible comet appeared at Leipzig and elsewhere. Eckstorm [Eckſtormius].

Kepler, in the *Cometar. Physiol.*, p. 120, reports that the comet of the year 1582, being retrograde, became nearer the ecliptic at the same beginning of Sagittarius, when it had likewise become stationary.

AD 1585. [Anno Chriſti 1585.]

[Margin: Tychonis obſervatio Cometæ 1585.] *Tycho's observation of the comet of 1585.* In the year 1585 from the birth of Christ, on October 18, Old Style [St. Vet.], I noticed (says Tycho, p. 13, *Epistolae Astronomicae*) a certain adventitious star [Stellam quandam Aſcititiam], endowed with a dim, rare and nebulous light, near the cord [linum] of the more southern Fish, which in its whole form was most similar to the nebulous swirl [nebuloſo gyro] that they call the Manger of Cancer [præſepe Cancri], except that [niſi quod] at the beginning, around this day and some following days, it seemed somewhat larger than that very swirl [hoc ipſo gyro]. [Margin: Figura atque magnitudo Cometæ.] *The figure and size of the comet.* So much so that, if one looked more carefully at its very extremities, it very nearly equalled the star of Jupiter [Jovis Stellam] in apparent size, although, because of the dark appearance of its dull light, it by no means presented itself to the eyes as clearly as the planets or the fixed stars, coeval with the world [Mundo coæva]. In the middle part of its body, however, it was endowed with a denser light, but around the extremities it was rarer and fainter [diſparentior].

[Margin: Cometa absque ullis crinibus apparuit.] *The comet appeared without any hair.* It was also perfectly round on every side, and it put out no tail or beard toward one part more than another, except that on the 20th and the 22nd [die 20 & 22] a slender trace of some delicate little ray, scarcely a span long, was thought by those looking very sharply and for a long time to extend toward the west, as far as could be seen [quo ad viſum]. Nor could anything of this kind be observed in it at other times during its whole duration. [Margin: Corpore paulatim diminutus eſt.] *It diminished gradually in body.* It diminished successively, however, so that around November 4 it was a little smaller than the nebulous swirl of Cancer mentioned above, with which it still agreed exceedingly well in colour and form. Then, becoming gradually smaller still, it disappeared entirely around the middle of November.

[Margin: Locus, Cur. usq; Comet[[a/æ]].] *The place and course of the comet [?].* On the first night on which we observed it, it was not far removed from Saturn, which was then retrograding near the little stars in the Cord of the Fishes [in Lino Piſcium]; it had already passed Saturn toward the east by somewhat more than five degrees [quinis gradibus]. It then crossed the whole constellation of Aries, and passed over the back of Taurus toward the north, where, not far

from the Pleiades (which, although it exceeded them in northern latitude, it did not reach in longitude), it ceased to be seen. What motion it actually had with respect to the equator and the ecliptic is clearly evident from the little table [Tabellâ] attached at p. 14 of Tycho's *Epistolae Astronomicae* [Epiſt. Tych.]. [Margin: Semita fuit ſectio circuli maximi.] *Its path was a section of a great circle.* From these motions he concluded that this comet, by its proper motion, described an arc of a great circle, which nevertheless successively admitted a somewhat variable inclination to the equator and the ecliptic, and which crossed the equator at 14° 55′ from the vernal intersection, and the ecliptic at 27° 38′ of Aries.

[Margin: Variatio anguli Orbitæ & Eclipticæ, nec nonÆquatoris.] *Variation of the angle of the orbit and of the ecliptic, and also of the equator.* The change (of which I spoke) took place by this law: around the midnight following noon of the 18th day [diei 18], the angle of declination to the equator was about 45° and a half [45° cum ſemiſ. ferè], and to the ecliptic 23° 17′. This angle decreased step by step, so that on November 4 it was 44° 50′ to the equator, and the inclination to the ecliptic 22° 21′; and at the end of the apparition, on the 12th day [die 12], the same was found to be 44° 19′ with respect to the equator, and 21° 34′ with respect to the ecliptic. And in this way, in the intermediate intervals too, the obliquity of the comet's portion of a circle to the equator and the ecliptic decreased gradually, by a regular diminution.

[Margin: Motus apparens in ſuà orbitâ in dies retardatus eſt.] *Its apparent motion in its orbit slowed day by day.* Its own daily motion along this course was also somewhat greater at the beginning, so that from the 18th to the 19th [à die 18 in 19], around the first observation made by us, it was 2° 18′; on the following days it became successively slower, so that from November 4 to 5 it advanced 55½′, and from the 12th to the 13th of the same month by only 34′ [34 ſaltem ſcrupulis]. [Margin: Cometa in æthere extitit.] *The comet existed in the aether.* And it kept this checking [inhibitionem] of its course regularly and proportionally, so that even from this general track of the comet, both by reason of the inclination of the arc of the great circle that it marked out by its motion, and also by reason of its proper progress compared with one another [inceſſus proprii invicem collati], it can be sufficiently proved that it by no means belonged to the elemental region [Elementaris regionis], as some fiery meteor [Meteoron] generated in that region, as the Aristotelians strive to persuade, with certain subtleties of their own established geometrically by no experience or demonstrations, that this is common to all comets [velut Ariſtotelici omnibus Cometis id commune eſſe, ſuis quibusdam ſubtilitatibus nullâ experientiâ, aut demonſtrationibus Geometricè ſtabilitis perſuadere nituntur.]. [Margin: Parallaxis ejus fuit inſenſibilis.] *Its parallax was insensible.* Finally, having examined the apparent places of the comet, he affirms that it was subject to scarcely any sensible parallax [vix ulli ſenſibili parallaxi obnoxium]; and yet, if it had been in the concave of the Moon [in concavo Lunæ], it would have had to have a large parallax, sensible not only with instruments but also with the naked

eyes, even by a mere look at the neighbouring fixed stars [vel ſolo intuitu ad vicinas Fixas]. [Margin: Quo loco reſederit Cometa juxta Tychonem.] *Where the comet sat, according to Tycho.* He therefore concludes that this comet was generated not only above the Moon, but in the highest aether, either above the Sun itself or certainly not far below it. For Tycho says, at p. 118, and in volume II, p. 442 [pag. 118,& tomo II,p.442.]. This comet of 1585, which beyond all doubt was carried far above the Sun, so much so that the most learned man Christoph Rothmann (who agreed with me exceedingly well in unravelling its parallaxes) did not hesitate to place it in the most remote sphere of Saturn, resisted the revolution of the first mobile near the first beginnings of its apparition, by its own proper daily motion, by a full three degrees [integris ternis gradibus]. Elias Olai, Tycho's assistant in astronomical exercises [Tychoni ab Aſtronomicis exercitiis], observed entirely the same, as can be read in the *Astrological and Meteorological Diary* [Diario Aſtrologico & Meteorologico] printed at Uraniborg in the year 1586.

[Margin: Obſervatio Chriſt. Rothmanni Cometæ 1585.] *Christoph Rothmann's observation of the comet of 1585.* Christoph Rothmann observed this same comet on October 8, Old Style [St. V.], at 9^h in the evening [hor. 9 veſp.], in 23° 9′ 2″ of Pisces, with a southern latitude [latitudine Merid.] of 13° 52′ 9″ (as can be read in the *Description* of the same comet [Deſcript. ejusdem Cometæ], p. 70). It appeared in a certain somewhat faint and round form [Specie quâdam ſublucidâ ac rotundâ], in the manner of a halo [in modum Halonis] around some star in denser vapours. [Margin: Figura ejus atque magnitudo.] *Its figure and size.* In its size it seemed to equal Venus when she appears largest, or even almost to exceed her; except that, because of the nebulous dullness of its light [nebuloſam luminis obtuſionem], it by no means met the eyes as clearly as the other stars. Its centre was of more compact and denser light, and it appeared almost like a little star of the fourth magnitude. Around November 8, when it was already gradually fading, it was very similar to that nebula in the breast of Cancer which is called the Manger [Præſepe].

[Margin: Motus ſegnior factus eſt.] *The motion became slower.* Having therefore carefully compared the observations, I found that the daily motion of the comet decreased in a certain proportion, from October 8 to the 19th of the same month ever more and more, but from October 21 to the end, in turn [rurſum], less and less. The motion in latitude also decreased in the same way. When, therefore, I inquired into the cause of this, [Margin: Variatio anguli inclinationis Orbitæ.] *Variation of the angle of inclination of the orbit.* I found that the angle of section [angulum ſectionis] of the circle of the comet and of the ecliptic had decreased ever more and more by a certain motion of libration [motu quodam librationis], etc.: the comet was in the ecliptic itself on October 22 at 13^h 20^m after noon [hor. poſtmerid. 13 20′], at which time the place of the comet in longitude was 27° 35′ of Aries. [Margin: Quænam Zodiaci Signa peragraverit.] *Which signs of the zodiac it traversed.* The comet's proper daily motion in longitude was 3° 1′ at the beginning; at the last, on

about November 10 [ultimò ferè die 10 Novembr.], only 34′. It advanced with a continuous direct motion from Pisces to the middle of Taurus. For at the beginning it was found in 23° 16′ of Pisces, but at the last in 17° 36′ of Taurus. On the parallax of this comet he has the following toward the end of chap. III [ſub finem cap. III]: [Margin: Quanta fuerit Parallaxis.] *How great the parallax was.* It has therefore been shown sufficiently and more [Satis igitur ſuperq́;] that this comet had no parallax: a parallax which, even if it had been scarcely half a minute, would nevertheless easily have been noticed by me, with that diligence, with these most accurate instruments. It therefore remained either in the sphere of the fixed stars, or in the sphere of Saturn, or in the sphere of Jupiter, etc. [Margin: Cometa in Orbe reſedit Saturni.] *The comet sat in the orb of Saturn.* Having, however, carefully weighed the reasons on both sides, we judge that it remained in the sphere of Saturn.

Since the circle too, which the comet described with its body, had, as I proved above, a certain inclination and libration toward Saturn [ad Saturnum], and its intersection with the ecliptic was not far from Saturn [Cùm Circulus quoq́ue, quem Cometa corpore ſuo deſcripſit, inclinationem & librationem quandam, ut ſupra probavi, ad Saturnum habuerit, ejusq́; interſectio cum Ecliptica non procul à Saturno abfuerit.]. If anyone, however, thinks it should be placed otherwise, let him follow his own opinion [ſuo utatur placito]; only let him know that it was either in the sphere of Saturn, or in that most ample space which lies between the sphere of Saturn and the firmament: which very thing, however, the speed of its motion and its kinship with Saturn [cognatio cum Saturno] seem to refute. Christoph Rothmann, in the *Description of the Comet of 1585* [Deſcript. Cometæ 1585].

[Margin: Obſervatio Ill. Principis Hasſiæ.] *Observation of the Most Illustrious Prince of Hesse.* The Most Illustrious Prince of Hesse [Illuſtriſſ. Princeps Hasſiæ], for his part, detected this comet on the 19th, in the evening [die 19 veſp.], not indeed with any instrument, but only marked by straight lines on a globe; and he detected it at 21° of Aries, with a southern latitude [latit. Merid.] of 4°. It was small (he says) and haired all round, so that he judges it to be of the number of the haired ones [Crinitorum], or of the Circaei [Circæorum]: as can be seen from his letters written to Tycho, p. 4.

AD 1590. [Anno Chriſti 1590.]

[Margin: Tychonis Brahæi Obſervatio Cometæ 1590.] *Tycho Brahe's observation of the comet of 1590.* [Margin: Puſillus Cometa.] *A very small comet.* In AD 1590 [A. C. 1590], on February 23, when the star of Venus, approaching the Earth as it descended, was at about its greatest distance [remotionem] from the Sun, I observed a comet, not very large, but shining with a pale and dim face (notes Tycho, Book I, p. 176, *Epistolae Astronomicae* [Epiſt. Aſtron.]) [Margin: Locus.] *Place.* between the asterisms of Andromeda and Aries, showing itself beyond the usual near the Northern Fish [Piſcem Borealem]; which from time to time was seen to put forth some little rays toward the zenith [verticem].

[Margin: Sub tramite circuli magni incesſit.] *It advanced under the track of a great circle.* By its proper motion it described an arc of a great circle exactly [ad amusſim], so that throughout the whole time of its duration it did not deviate from it at all, either on this side or beyond [cis vel ultra]. And this by such a law that, if that arc had reached the equator, it would have crossed it at its part 339° 45′ [in parte ejus 339 m. 45], with an inclination to it of 42° 0′, which was always like itself and remained entirely the same. It stood, moreover, a little more than 37° from the point of the intersection with the equator just mentioned [dictæ], when it was first noticed by us. [Margin: Quantum cœli ſpatium peragraverit.] *How much space of the sky it traversed.* But when at the last it ceased to be seen, it had completed not quite 80 degrees in the same [non planè 80, in eodem gradum abſolverat]. And so it nearly traversed half the sky, a quadrant [dimidium cœli quadrantem]. Perhaps, however, it completed this one too, or even at some time exceeded it, if only the exact limit of its beginning and of its dissolution had been established. With what progress, moreover, it carried out its motion in this very track of a great circle, within these twelve revolutions of the universe during which it was noticed by us [intra has duodenas, quibus nobis animadvertebatur,univerſi circumitiones], the little table [Tabella] at p. 181 of the *Epistolae Astronomicae* [Epiſt.] shows clearly. [Margin: Cometa ſecundùm ſ. Signorum progreſſus eſt, motu proprio ſucceſſivè lentiori.] *The comet advanced in the order of the signs, with a proper motion successively slower.* So that on February 23 the longitude was 18° 27′ of Aries, and the latitude 18° 14′. But at the last, on March 6, its longitude 3° 15′ of Gemini, and its latitude 20° 46′. The daily motion, however, was 7° 34′ at the beginning, but 1° 34′ at the end.

[Margin: Capitis figura atque magnitudo.] *The figure and size of the head.* Its head was indeed a little larger at the beginning than afterwards, yet it scarcely held three minutes in diameter, being successively diminished from then on. It also appeared rather dim and less compact, and not shining like the other stars. [Margin: Caudam in oppoſitum Solis expoſuit.] *It set its tail opposite the Sun.* Its tail too, very thin and rather sparse, it directed exactly toward the parts opposite the Sun, as long as it could be noticed. For on February 13 it extended it exactly toward the brighter one in the left foot of Andromeda; but on the following day it looked toward the brighter one in the body of Perseus, not precisely, however, but deflecting somewhat from it toward the one which is at the flank [ad ilia], of the third magnitude, by a fourth part of the interval between the fixed stars. On the 25th [Die 25] it pointed fairly exactly to this very one near the flank. On February 26 it looked toward the bright one of the head of Medusa.

After that time, the train of the tail could scarcely be made out [Poſt id temporis caudæ ductum animadvertere vix licuit], partly because of its own thinness, partly because of the moonlight, which grew stronger day by day. Yet on the first day of March, whose evening had an exceptionally clear air, it still appeared a little, so that to those watching attentively it pointed with a

slender trace to a little star of the third magnitude next to the lowest loin of Perseus [juxta infimi lumbi Perſei]. [Margin: Cauda evanuit.] *The tail vanished.* After that the tail was nowhere seen by us. For on March 2 [die 2 Martii], even after the Moon had gone below the horizon, it was not discerned. From the extensions of the tail [caudæ porrectionibus] that we have indicated, moreover, it is clearly gathered that it was everywhere turned exactly away from the Sun, provided only that the positions of the Sun are compared with the places of the comet's head which they held at the same times; so that on this account there can be no doubt that those hairs [crines] are produced accidentally [per accidens] by the solar rays passing through the less compact body of the comet. [Margin: Longitudo Caudæ.] *Length of the tail.* The length of the tail around its first appearance was seen to be about ten degrees at most; in the days immediately following it became more contracted, so much so that around the beginning of March it was of such slenderness that it scarcely struck the senses of the eyes.

I examined the parallaxes of this comet with all the diligence that was possible, since I know that by their help that which is most disputed by philosophers in such phenomena can be settled. [Margin: Cometa hic, omnis planè parallaxeos fuit expers.] *This comet was entirely without any parallax.* When I had considered and accurately weighed all the observations, made carefully for that purpose with three or four most exactly constructed instruments, I found in this comet no parallax [aſpectûs diverſitatem] at all, not even of a single minute [ne quidem unius ſcrupuli], from a comparison of a higher and of a lower position, together with the proper motion, often made finely and diligently. [Margin: Neutiquam à ductu circuli maximi discesſit.] *It in no way departed from the track of a great circle.* For in its course it described exactly, over the whole time of its appearance, the arc of a great circle in the sphere, departing from it in no direction by a single minute [nullo minuto] (such a direction of its path under the same track, kept up for so long a time, did not suit at all a meteor wandering in the sublunar air); and this with the observation made at a high as well as at a low altitude, and with refractions skilfully avoided where needed: and geometrical demonstrations prove that, had the comet admitted a sensible parallax, these could by no means have agreed with one another, as is clear enough to anyone who understands these matters. And therefore it is certain that the comet had either no parallax at all or one surely imperceptible to the senses; [Margin: Diſtantia Cometæ à Terrâ.] *Distance of the comet from the Earth.* and consequently that it is not only to be placed in the aether itself far above the Moon, but also that it was scarcely nearer than the solar orb [Solari Orbe propiorem vix extitisſe].

[Margin: Quando diſparuerit.] *When it disappeared.* After the sixth day of March the comet was nowhere seen any more; indeed on that same evening it was so slender that it would allow itself to be marked with the instruments only with the greatest difficulty, for unless by those strong in keenness of sight it was scarcely made out even when the place was pointed out, the rays of the Moon dimming still further its body, which was in itself very much attenuated. I therefore watched diligently after the full moon had passed, around the days

immediately before the middle of March, whether in the evening hours, before the Moon had risen, some trace of it remained; but none at all was to be found anywhere. [Margin: Quousque duraverit.] *How long it lasted.* It therefore did not last long after the sixth of March, nor was it much visible before February 23 [ante 23 Febr.]. And so its whole period was completed in about half a month.

AD 1593. [Anno Chriſti 1593.]

In AD 1593 [A. C. 1593], a comet (caused by the opposition of Saturn, Jupiter and Mars) appeared in the cardinal solstitial signs on the tenth day of July, before sunrise, with the Sun occupying the last degree of Cancer. [Margin: Locus motusq; Cometæ.] *The place and motion of the comet.* By its own motion it advanced from the Tropic of Cancer, from the south, northward over the whole of Europe, or the Arctic circle. It made its retrograde motion from Cancer through Gemini and Taurus in such a way that on August 17 it was seen near the Arctic circle, at the beginning of Taurus, and near Cepheus it vanished on August 21. Rockenbach [Rockenbachius].

Froidmont [Fromondus] mentions the comet of the year 1593 in book III of the *Meteorologica* [Meteorologicorum], chapter 1, article 1; he likewise places it above the Moon on the authority of Tycho, though from what source I do not know. Riccioli [Ricciol.], book VIII, section 1, on comets [de Comet.].

AD 1596. [Anno Chriſti 1596.]

[Margin: Cometa barbatus.] *A bearded comet.* In AD 1596 [A. C. 1596], on July 9, at about the first of the night [circa primam noctis], a bearded comet was first seen by certain learned men in the northern region of the world [in plagâ mundi Septentrionali], among the stars of Ursa Major [Urſæ majoris], on the horizon of Frankfurt on this side of the Oder [in horizonte Francofordiano cis Viadram]. [Margin: Ejus curſus.] *Its course.* Advancing gradually by its own motion, it reached the hind parts of the Bear just named. Soon afterwards, touching also the beginning of Leo, in the hind foot, it was seen on the following days, as some will have it. [Margin: Capitis color.] *Colour of the head.* The head of the comet showed the colour of the planet Saturn; [Margin: In adverſam Solis plagam caudam exporrexit.] *It stretched out its tail toward the region opposite the Sun.* the tail was stretched from the head into the part opposite the Sun, toward the pole of the ecliptic, toward the south; and then, a few days later, it vanished. Rockenbach [Rockenbachius].

In AD 1596 [A. C. 1596] a comet blazed which travelled through Cancer, Leo and Virgo; [Margin: Quænam Signa Zodiaci trajecerit.] *Which signs of the zodiac it crossed.* noticed under the mouth of Ursa Major, it hastened to Coma Berenices. Eckstorm [Eckſtormius], from the *Chronolog.* of Bucholtzer [Bucholtzeri].

In AD 1596 [A. C. 1596], Josephus Bonfilius, in the *Sicilian History* [Hiſtoriâ Siculâ], part 2, book 10, says that two comets were seen under Ursa Major in

the sign of Virgo. [Margin: Ex directo factus eſt Stationarius Cometa.] *From direct, the comet became stationary.* And Kepler [Keplerus], in the *Physiolog.*, page 120, says that in this year the comet proceeded out of Cancer, and at the end, from direct, became stationary as to longitude, its path bending toward 4° of Virgo [quoad longitudinem flexo itinere ad Grad. 4 Virginis].

[Margin: Mæſtlinus Cometam circa Stationem deprehendit.] *Mästlin caught the comet around its station.* In AD 1596 [A. C. 1596], on August [?]/13, the comet was seen for the last time by Mästlin, having by then become almost stationary at 4° of Virgo. Kepler [Kepl.], page 112, on the new star in Serpentarius [de novâ Stellâ in Serpentario].

[Margin: Obſervatio Rothmanni Cometæ 1596.] *Rothmann's observation of the comet of 1596.* Yet as soon as I learned of it (which was on July 21 of the year 1596), I at once, in the evening, set myself to observe it, and after 10^{h} of the night [poſt 10 hor. noctis] I caught sight of it in the hindmost foot of Ursa Major, a little above its two stars of the third magnitude, [Margin: Quo loco initiò viſus fuerit.] *In what place it was seen at first.* so that it stood almost in the same straight line with the upper of them and with the star in the knee [poplite] of the preceding foot, though a little lower toward the east: it was distant from the upper star of the foot just mentioned by twice the interval between the fixed stars of the foot themselves. Hence, looking back to the places of the fixed stars, I estimated by simple sight that it was at 28° of Leo, with a northern latitude of about 27°[?] 30′. [Margin: Directio Caudæ, ejuſq; deviatio.] *Direction of the tail, and its deviation.* But its tail stretched toward the last one in the tail of Ursa Major, yet departing a little from that line toward the west, so that it was not directly opposite the Sun, but deviated a little toward the upper parts. On the following days I could not see it because of the cloudy and rainy weather, except on July 25, when, together with the two stars already mentioned in the foot of Ursa Major, it formed an isosceles triangle, standing toward the west. Here, however, I distrusted myself, because with very great difficulty [propterea quòd difficillimè] it could be made out [conſpici poſſet] on account of the vapours and the light of the Moon, which dimmed stars of the third magnitude. For the comet itself also had, in a way, such an appearance. [Margin: Quantum ſpatium in ſuo tramite emenſus ſit, & quo motu fuerit præditus.] *How much space it traversed in its path, and with what motion it was endowed.* I therefore estimated by simple sight that in the meantime it had completed about 4° in its course in the zodiac, a little more; and therefore that its daily motion was about 1°. For the latitude seemed to me to have become smaller by nearly 2° [minor facta 2 propè Grad.], as if at the earlier time it had stood in the Bear itself [in ipsâ Ursâ]. Christoph Rothmann [Chriſtoph. Rothmannus], toward the end of the *Description of the Comet of 1585* [Deſcript. Cometæ 1585], page 155.

AD 1597. [Anno Chriſti 1597.]

In AD 1597 [A. C. 1597] a comet was seen, about which Antonius Santutius [de quo Antonius Santutius], in the month of July, before the 16th day [ante diem 16], and it lasted until August 9. [Margin: Duratio Com[Lacuna: ink blot]æ 1597.] *Duration of the comet [?] of 1597.* Riccioli [Ricciolus], book VIII, section I, on comets [de Comet.], page 15.

AD 1607. [Anno Chriſti 1607.]

[Margin: Kepleri Obſervatio Cometæ 1607.] *Kepler's observation of the comet of 1607.* In AD 1607 [A. C. 1607], on September 16/26, a Wednesday [feriâ quartâ], at Prague, with a clear sky, at night, half an hour past the eighth from noon [noctis, horâ dimidiâ ſupra octavam à meridie], I saw a star under the Bear (says Kepler [Keplerus], page 25 of *de Com.*), larger than the others when I looked through eyeglasses [per perſpicilla], which without eyeglasses seemed to me to spread a light equal to the other fixed stars. I myself saw no tail, but the others, when asked, affirmed that they saw it. [Margin: Cometæ locus.] *The place of the comet.* It stood near the following knee of the Bear, toward the preceding one [propè genu Urſæ ſequens versùs præcedens], a little higher than that star, toward the quadrilateral; its latitude was nearly 35° 30′, and its longitude about 20° 0′ of Leo.

[Margin: Fuit æthereus.] *It was aetherial.* For the rest, the author just mentioned asserts that the comet was higher than the Moon, and by no means in any region of the air. [Margin: Deviatio Caudæ à Solis oppoſito.] *Deviation of the tail from the opposite of the Sun.* On October 1 the tail stretched toward the double one of the Belt [duplicem Cinguli]; it therefore turned aside a little from the opposite of the Sun toward the preceding parts of the signs [præcedentia Signorum]. The same was noticed on October 2, when it stretched its tail to the star of the Crown which is next to the largest, both in brightness and in place, etc.

[Margin: Quando iter ſuum incurvare c[[æ/œ]]perit.] *When it began to bend its path.* On October 10 a curving of its path [incurvatio itineris] already began to be noticed: for before, it was carried as if toward the stars of the hand; now it appeared clearly enough that it would pass below the hand.

[Margin: Cometa tandem Stationarius & Retrogradus factus eſt.] *The comet at last became stationary and retrograde.* On October 22, although it could no longer be observed with instruments, it was nevertheless seen to fall at 1⅚° of Sagittarius; it had therefore become retrograde, or certainly stationary, with a latitude of 9¾°. It stretched its tail below the knee, as if toward the following hand, quite precisely opposite the Sun. On October 26, however, it was seen by Kepler [Keplero] for the last time.

[Margin: Ab aliis hic Cometa citiùs obſervatus eſt.] *This comet was observed earlier by others.* By others, however, this comet was noticed on September 13/23, on the testimony of Brengerus [Brengero]. Yet in the evening of September 12/22 it had not yet shone, as Kepler [Keplerus] would have it, page 115.

[Margin: Caput minimè fuit rotundum.] *The head was not at all round.* To one looking carefully, the shape of the head seemed somewhat swollen [ſtrumoſa], falling short of roundness. Size greater than all the fixed stars, light weak, pale, watery, like that of the Moon standing near the shadow of the Earth, in that it spread less in my eyes (Kepler's, that is [Kepleri ſc.]) than that of the fixed stars. [Margin: Longitudo atque vibratio Caudæ.] *Length and quivering of the tail.* After the full moon had passed, even with the Moon still bright, the tail could be seen more clearly, now short, and suddenly quite long, to 8° and 10°, flickering like the rods of chasmata [virgæ chaſmatum]. Toward the end of the appearance the head grew smaller and smaller, and the tail at last vanished, since the comet was hastening toward its heliacal setting, and on October 22 and 26 appeared only low, above the mountains, in bright twilight, below the knee of Ophiuchus, a star which it nearly equalled, bearing the look of a cloud more closely than that of a star. [Margin: Quousque duraverit Cometa.] *How long the comet lasted.* Therefore, with both the Sun approaching and the comet descending toward the ecliptic, although [etſi] it outlasted October 26 [ſuperfuit diei 26 Octob.], it nevertheless could not have been seen beyond three days [ultra triduum], even if the sky had been clear.

[Margin: Curſus Cometæ.] *The course of the comet.* The path of the comet through the constellations was this. Having arisen under the front foot of the Bear [ſub priore pede Urſæ], it grazed and passed through the belly of the Bear, and cut as it were through the middle of Boötes; from there it crossed into the constellation of the Serpent, and, having run through it along its length, when it had begun to bend its course under the front hand of Ophiuchus, it at last came out into his front foot and stuck in the shin [tibia]: nor do I think that it reached the ecliptic, however long, even very long, it might have survived [quantumvis vel longisſimè ſuperfuerit].

[Margin: Tempus primæ apparitionis.] *The time of the first appearance.* The time at which the comet first arose is marked by the autumnal equinox [æquinoctio autumnali], and by the opposition of Jupiter and the Sun in the beginning of Aries and Libra, and likewise by the triangle of Saturn and Mars [triangulo Saturni & Martis]. At the end of the appearance, too, Mars was opposite Jupiter, exactly in the equinoctial points. The path along which the comet was carried appeared from these lands [ex his Terris] as nearly as possible a great circle; [Margin: Vltimò, Cometa ſub inſigni incurvatione incesſit.] *At the end, the comet advanced with a marked curving.* in the last days, however, it curved strongly toward the ecliptic. For it was thought to move more downward toward the ecliptic than straight on along the ecliptic [quàm ſecundùm Eclipticam prorsùs].

[Margin: Quâ veloci. tate fuerit præditus.] *With what speed it was endowed.* On September 30 its daily one [diurnus] was at its greatest, 13°, as great as the motion of the Moon; it was slower before and after, and that in order [ordinatè], always decreasing by smaller decrements; and finally, from the 19th to October 26 [à 19 in 26 Octobr.], it showed the appearance of a station as to longitude. Since, moreover, its northern latitude was great at the beginning, [Margin:

Cometa perpetuæ fuit apparitionis.] *The comet was continuously visible.* so that it was seen in the morning before the Sun and in the evening after the Sun, so much so that it did not even set in Germany, if anyone stayed up through the night, it came about that the common people, pointing with the finger to the different quarters of the comet [diverſas Cometæ plagas], raised the opinion of two comets. So Kepler [Hæc Keplerus], in *Comet. Physiolog.*

[Margin: Longomentani Obſervatio Cometæ 1607.] [recte: Longomontani] *Longomontanus's observation of the comet of 1607.* Severinus Longomontanus also carefully observed this comet, as may be read in chapter IX of *On the New Phenomena of the Heavens* [de novis Cœli Phænomenis]. On September 18, Old Style [St. V.] (he says), I first noticed and at the same time observed a tailed comet in the north, [Margin: Color atque magnitudo.] *Colour and size.* which by its size almost rivalled Jupiter himself to the eye, but, with a darker, that is a somewhat livid colour [colore ſublivido], Saturn himself. [Margin: Cauda in partes Soli adverſas projecta fuit.] *The tail was cast into the parts opposite the Sun.* It also had a fairly long and dense tail, which the solar rays had driven straight into the region turned away from them, and that through the whole duration of the comet. [Margin: Situs.] *Position.* For on this evening after 7^{h} [poſt hor. 7], when the comet stood scarcely at the distance of one Moon below the small unformed star behind Ursa Major [infra parvam informem poſt Urſam majorem] (which we noted here with no less diligence than Joh. Kepler [Joh. Keplerus] in Bohemia on the same evening), I also found that the comet with its tail pointed to two unformed ones [binas informes] below the root of the tail in Ursa Major, the Sun namely running through 5° of Libra. [Margin: [[c/C]]auda admodùm denſa extitit.] *The tail was very dense.* The tail of the comet was also dense, as I said, and perhaps more compact than the others usually are, and of the same colour as the head itself, namely livid and somewhat Saturnine [ſubſaturnini].

[Margin: Quo die illuxerit.] *On what day it first shone.* For the rest, he affirms that this comet did not shine forth before September 15/25 [ante diem 15/25 Sept.], since on the 24th he observed Jupiter and found nothing new in the sky. He thinks it consistent, however, that the comet first shone at the time when there was a conjunction of Mercury with the Sun and a trine aspect [trinus aſpectus] of Saturn with Mars. [Margin: Motus in ſuo tramite ab initio fuit rapidiſſimus, deinde paullatim ſegnior.] *Its motion in its path was very rapid at first, then gradually slower.* Its motion in its own circle was very swift from the beginning, so that in the great circle proper to it [in circulo maximo & proprio] it ran through 9° and more in the first days; afterward, however, it decreased proportionally with the magnitude [proportionaliter cum magnitudine]: for on the last day, namely October 16, it traversed only 5′ [non niſi 5′ trajecit].

Note, moreover, that the comet mentioned [dictus Cometa] crossed the equator on September 29 [die 29 Septembr.], a little after 236°. [Margin: Cometa à circulo maximo haud parùm deflexit.] *The comet deflected not a little from a great circle.* Indeed, it was first clearly detected to have deflected from the

path of a great circle on October 1 [die 1 Octobr.], when it had almost reached the stars in the left hand of Ophiuchus. [Margin: Quanta fuerit Parallaxis.] *How great the parallax was.* It had a parallax of not more than 3′; and so he asserts that the comet was entirely celestial.

[Margin: Gottifredi WendeliniObſervatio Cometæ 1607.] *Govaert Wendelen's observation of the comet of 1607.* At Forcalquier [Forcalcarii] in the province of Marseille [in Provinciâ Masſilienſi] they saw this comet as early as September 25 [die 25 Sept.], on the authority of Govaert Wendelen [Gottifredo Wendelino] in his *Luminarcani Teratologia Cometica*, page 11. He himself, however, observed it only from October 8 [die 8 Octobr.] (at a little more than 21° of Scorpio, with a latitude of 21° 50′) up to November 5 [5 Novembr.]. [Margin: Quamdiu ab illo fuerit viſus.] *How long it was seen by him.* The whole duration therefore lasted 41 days, during which the motion was in the order of the signs, from northern latitudes into southern ones; [Margin: Motu incesſit directo, & quidem in ſuâ orbitâ ſub arcu circuli maximi.] *It advanced with direct motion, and indeed in its orbit under an arc of a great circle.* and it crossed the ecliptic at 17° 12′ of Sagittarius, with a southern inclination of 41° 7′ in all, and with its course slowing; and, as has so far been observed in nearly all, along the track of a straight path describing a portion of a great circle. [Margin: Cometæ ſunt corpora ætherea.] *Comets are aetherial bodies.* By this argument it is clear enough that they are not sublunary and disorderly meteors, such as are generated in the highest region of the air, but that they both arise and complete their course in the aether most remote from us, far above the Moon.

What the form of this comet was like in the first days I did not learn. [Margin: Mira Cometæ facies.] *The wonderful appearance of the comet.* When I began to watch it, I was amazed, seeing as it were a fiery spear or a flaming sword. [Margin: In plagam Soli obverſam Cauda tendebat.] *The tail stretched toward the region facing the Sun.* For the tail was cast from the head into the parts turned away from the Sun, and ended in a point, about seven degrees long; it burned clearly until it was blotted out at the boundary of the evening twilight, and at the same time it had burned away and at the same time, thinned out into parts, had gone off into down [in pappos], as certain flowers do.

[Margin: Nulla Parallaxis fuit deprehenſibilis in hoc Cometâ.] *No parallax was detectable in this comet.* I tried to track down the parallaxes of this comet, if not by suitable instruments, at least by the whole course of its path, making a comparison with the hand of Ophiuchus and other stars (conveniently offered in Kepler's [Kepleri] work *On the New Star* [de novâ Stellâ]); but I could detect none, not even the smallest. Therefore, trusting my own diligence and undertaking a bold deed, I began to declare that this comet had been above the Moon and had unfolded its courses in the highest aether. Govaert Wendelen [Gottifredus Wendelinus].

AD 1618. [Anno Chriſti 1618.]

In AD 1618 [A. C. 1618], four very different comets appeared, [Margin: Quatuor Cometæ uno anno conſpecti ſunt.] *Four comets were seen in one year.* as Riccioli [Ricciolus] indeed seems to confirm, from various observations and not so obscurely, in his *Almagestum* [Almagaſto] [recte: Almageſto], Book VIII, Section I, On Comets [de Cometis]. Since he described the earlier ones carefully, more than the rest, I wanted to attach their history here as it was written by that author.

In AD 1618 [A. C. 1618], besides fiery beams and flying dragons [Trabes igneas & Dracones volantes], three or four comets appeared. [Margin: Primus Cometa anni 1618.] *The first comet of 1618.* The first appeared on August 25 [Auguſti die 25] in Upper Hungary [in Hungariâ ſuperiori]; as Kepler [Keplerus] reports in *On the Comets of This Year* [de hujus anni Cometis], page 47, it came forth before sunrise, around the third hour from midnight, [Margin: Caudam Occaſum versùs explicuit.] *It spread its tail toward the west.* casting its tail from the east toward the west, that is (as comets usually do) turned away from the Sun; its tail was short and broader than the head, so that it imitated clothes-brushes [ſcopas veſtiarias]. On the first day of September it was seen at Linz [Lincii] by Kepler a little below the left front foot of Ursa Major, and turning aside [declinansq́;] toward the head of Leo, so much so that it seemed to be at 10° of Leo, with a northern latitude of 21½° [latit. Bor. 21½ grad.]. [Margin: Motu retrogrado ſucceſſivè lentiori vectus eſt.] *It was carried with a retrograde motion that grew slower by degrees.* On September 2 [Die 2 Septembr.], keeping its latitude, it advanced one degree in retrograde motion toward the preceding signs [in antecedentia], and after some days it became slower in its motion. On the 6th [Die 6] no tail could be observed with the naked eye, but viewed through the telescope [Teleſcopio inſpect[9]] it appeared fairly large, like a small cloud, with very short stubs of hair standing upward. [Margin: Quò Cœli loco hæſerit.] *Where in the sky it stood.* On the 23rd [Die 23] it was seen to have reached 29° 42′ of Cancer, with a northern latitude of 23° 41′; and through the telescope it was seen to be shaggy [villoſus], with a broad and very short head of hair [capillitio], but nebulous, and with a light that did not twinkle in the least. On September 25 [Die 25 Septembris], around 28° of Cancer and at a latitude of 23¼°, it disappeared. Since, however, its parallaxes could not be deduced for lack of observations, nothing certain can be established about its distance from the Earth. [Margin: Kepleri, opinio de Cometæ hujus motu.] *Kepler's opinion on the motion of this comet.* Kepler nevertheless thinks that, because it lost its tail so quickly, it rushed toward the Sun along a line turned obliquely away from the Earth; and that, assuming an annual motion of the Earth, this comet with its daily motion at the beginning of its trajection equalled the daily motion of the Earth in longitude.

[Margin: Secundus Cometa.] *The second comet.* The second comet seems to be confused by the writers either with the beam [Trabe], or with the flying dragon [Dracone volante], or with the third comet: either because its tail

was visible long before the rising of the head, or before its recession from the Sun; or because, as Kepler on page 50 judges not improbable, it later divided into two, as Ephorus once related had happened, Seneca [Senecâ] objecting in vain. Wilhelm Schickard [Wilhelmus Schickardus] in Württemberg [in Wirtembergiâ] saw on October 20 New Style [20 Octobr. St. N.] a torch or flying dragon [facem ſeu Draconem volantem], from the head of Andromeda, through the Northern Fish [Piſcem Boreum], to the jaws of Cetus [ad rictum Ceti]. Perhaps this is the comet which Ursinus [Urſinus] reports was seen on October 30 [die 30 Octobr.] at Cologne [Coloniæ Agrippinæ], with a long train of tail toward the Borrhapeliotes [versùs Borrhapelioten], and which did not last long; but perhaps it was a meteor, not a comet. [Margin: Joh. Remi Quietani Obſervatio.] *The observation of Joh. Remus Quietanus.* But Joh. Remus Quietanus, in a booklet on this comet published at Innsbruck [Oeniponte], writes that at Novesium in Silesia [Noveſii in Sileſiâ], on November 10 [die 10 Novembr.], a fiery phenomenon was seen, like an ostrich feather and curved, the kind [quam ſpeciem] which the ancients called Ceratia [Ceratiam]. [Margin: Cauda incurvata.] *The tail curved.* And he adds that at Rome on November 10 [die 10 Novembr.], from $16^{h}\ 20^{m}$ to $18^{h}\ 40^{m}$ after noon [ab hor. 16 20′ ad 18 40′ poſt merid.], an arched beam was seen, which the Roman observer called a comet. It had an enormous tail at its side, whose end toward the horizon was gathered in the form of a handle, but was not brighter than the rest of the body, nor distinct from any star, perhaps because of the nearness of the Sun; and its other end lay between the autumnal section [ſectionem Autumnalem] and 18° of Libra [grad. 18 Libræ], bending away from the ecliptic toward the south by about 15° [grad. ferè 15]. Therefore, if it was a comet and turned its tail away from the Sun, its head must have been between 18 of Libra [18 Libræ] and 19° of Scorpio, near the last of Hydra [circa ultimam Hydræ], since on that day the Sun was at 19° of Scorpio. [Margin: Quando primùm viſus fuerit.] *When it was first seen.* But Georgius Sualbachius says that a comet was seen by him at Speyer [Spiræ] on November 7 New Style [die 7.Novemb.St.N.]. And at Linz [Lincii] the farmers on the outskirts saw the same radiance around November 12 [d. 12 Nov.], in the same region of the sky and at the same hour of the night as the Romans, as Kepler attests on page 52 [teſte Keplero p. 52.]. Joh. Bapt. Herbeinstreitus also attested that the same was seen at Ulm [Ulmæ] by travellers some weeks before December 4 [ante diem 4 Decembr.]. Herlicius writes that the same was observed in Pomerania on November 19 [die 19 Novembr.], and earlier in Prussia [in Boruſſiâ]. [Margin: Motus retrogradus hujus ſecundi Cometæ.] *The retrograde motion of this second comet.* Finally, the same one seems to be the one that was seen in the form of a horn among the stars of Crater at Tübingen [Tubingæ] around November 20 [circa diem 20 Novembr.] by Joh. Straussius [à Joh. Strausſio], and at Linz [Lincii] by Kepler on the same day among the same stars, at $5\frac{1}{2}^{h}$ after midnight [hora 5½ poſt mediam noctem], with a retrograde motion [cum motu retrogrado] and with its head hidden in the light of dawn [in Auroræ luce]. He adds that on November 23 [die 23

Nov.], at 5^h in the morning [horâ 5 mat.], it had turned aside from the stars of Corvus toward the south, toward the heart of Hydra [cor Hydræ]. But he speaks in such a way that you cannot tell whether he recognizes it properly as a comet, or as a meteor that was a forerunner [Prodromum] of the third comet; or whether the third was born from this one when it divided into two. The cause of this confusion was that the head was not seen clearly enough in the twilight by the Europeans; but in Persia and India it was clearly distinguished, this second one from the third, as I shall shortly relate.

Observations of the Third Comet of the Year 1618 [Obſervationes tertii Cometæ Anni 1618.] In the year 1618 [Anno 1618], around the middle of November [circa medium Novemb.], the third comet appeared, [Margin: Tertius Cometa an. 1618] *The third comet of the year 1618.* distinct from the second, of which above, and from the fourth, of which below, and unknown to Kepler, Longomontanus and most European writers. Of these, the third will be called the Fourth by us; but in Persia the third appeared distinct from the second, and in East India [in Indiâ Orientali] this third distinct from the fourth. For Longomontanus, in the Appendix to the *Astronomia Danica*, chapter 10 [Append. ad Aſtron. Danicam cap. 10], reports an observation of two comets [Margin: Inſignis Obſervatio in Perſiâ habitâ.] *A notable observation made in Persia.* made by García de Silva y Figueroa [Garciâ Silvâ Figuerôes], ambassador of Philip III, King of the Spains, in the town of Sphani [in Oppido Sphani], not far from Persepolis toward the west, under a pole height of 31° 30′; it was excerpted from his letter written on the 5th Kalends of March [5 Calend. Martii] of the year 1619 to the Marquis of Bedmar [ad Marchionem Bedmarum], which was translated into Latin and published at Antwerp [Antwerpiæ] in the year 1620. The closing passage [clauſula] of this letter was as follows: [Margin: Bini ſimul Cometæ conſpecti ſunt.] *Two comets were seen at the same time.* An account of the twin comets which in these days were a spectacle for us. One began to shine on November 10 [10 Novembr.], two hours before sunrise, and its appearance was noticed between the east and the south. [Margin: Capitis Color Cometæ prioris.] *The colour of the head of the earlier comet.* Its colour was quite like the smoke that rises from sulphur powder refined to the utmost [pulvere ſulphureo recoctiſſimo] when it is set alight. The head, as it seemed to me, was in Scorpio; its size such as would take up a sixth [ſextantem] of the zodiac; [Margin: Figura atq; longitudo Caudæ.] *The figure and length of the tail.* its form like a scimitar [acinacis], as some have asserted, a kind which the Greeks call Xiphiae [Xiphias], portending dreadful events. To me this comet seemed rather to present the appearance of a one-year-old palm shoot, which, not yet spread out, curves slightly at its tip. It held its motion, moreover, toward the south.

And so it is clear enough from this that this was the one imitating either a scimitar, or a Ceratia, or an ostrich feather, which we, with Kepler, have named the second comet. García [Garcias], moreover, continues thus: [Margin:

Facies Cometæ poſterioris.] *The appearance of the later comet.* On the twelfth or thirteenth day after the rising of this comet, the other appeared, maned or hairy [jubatus ſeu crinitus], of the ordinary appearance, like the star of Venus in colour, and of equal size, or a little larger. It took its rising directly from the equinoctial east; and although at first it was much smaller than the earlier one, it nevertheless grew by much greater increments from day to day, so that it almost equalled the other. It moved with the motion of the first mobile and also with its own, not far from the vertical line, toward the north. [Margin: Cometa breviſſimæ durationis.] *A comet of very short duration.* Further, three days after the rising of this one, or four, the other vanished. Both certainly had so short a period that the later one ceased to appear already beyond the tenth day. It was observed that this one, as it was ending, grew redder. Now if by the 13th day you understand November 13 [diem 13 Nov.], on which the third comet (which is García's second) rose, it follows that the second (which is García's first) was extinguished on November 17 [die 17 Novembr.]. But if by the thirteenth day you understand 13 days after the rising of the second (which is García's first), the third comet rose on November 23 [die 23 Novembr.] and ceased on December 3 [die 3 Decembr.]

which is more what the letter says [quod magis litera ſonat]. In either case, however, it is clear that this second comet of García's [ſecundum hunc Garciæ] is the third with respect to the first one seen in Europe, and that it is not to be confused with that third one which was famous among the Europeans and shone from November 24 up to January 20 of the year 1619, and which in truth must be called the Fourth. Granted, Longomontanus confuses it [eſto Longomontanus illum confundat]; and, on account of that increase it underwent, which can be understood of the tail, and of its brevity, he thinks that García, either through carelessness or because of the hindrances of his embassy, did not persevere, asserting otherwise that the comet had ceased [aliud affirmare Cometam deſiiſſe] — because he asserted this so expressly that in the same letter he said: However that may be, if these comets portend evils, at least they will not be lasting, like the very many other things that are seen in the world. Rather, one ought to have recognized from this that this comet was entirely different from the one which the Europeans saw as the third.

[Margin: Obſervatio P. Jacobi Rhò in Indiâ peracta.] *The observation of P. Giacomo Rho made in India.* This is confirmed by the letters of P. Giacomo Rho [P. Jacobi Rhò], of our Society, written from Goa [Goâ] to Europe. In them observations of the last comet are indeed recorded, begun from November 19, which we shall present below in chapter 22, number 23, and compare with the European ones; but mention is nevertheless also made of the other comet, although no observation of it is noted, namely that it vanished quickly. For so one reads in those letters, as Claramontius also has in the Supplement to the *Antitycho* [Antitychonis ſupplemento], page 34: [Margin: Duo ſimul Cometæ manè conſpecti ſunt.] *Two comets were seen together in the morning.* One thing alone could not be passed over by us without grave reproach, nor ought it to

have been: when we had scarcely entered port and were unprepared for that kind of observation, it happened that the sky was suddenly seen to shine with two comets, in the morning hours. This stirred up various rumours among the Moors and the heathen, astonished at the novelty of the thing. Afterwards, however, he relates observations made with the astrolabe and the astronomical radius [Radio Aſtronomico] of the College of Goa from November 29 through a great part of December.

[Margin: Quatuor Cometæ anno 1618 extiterunt.] *Four comets appeared in the year 1618.* It is therefore clear enough [Satis igitur conſtat] that before the comet which appeared from November 24 to January 22, three comets shone forth in the sky this year. The first, lasting about a month [menſtruum ferè], from August 25 to around September 25. The second, seen from November 10 up to the day not only of November 18 in Silesia, or of the 19th in Pomerania and in Prussia, but it was also seen in Persia and in Austria up to November 23. The third, seen in East India and in Persia from November 22 or 23 up to December 13. The fourth, from November 24 to January 20, which was the chief of the others of the year 1618, and the longest-lasting and most famous of all; of it we must speak shortly, and Kepler and the Roman observer call it the Third.

[Margin: Wendelini teſtimonium pro quatuor cometis.] *Wendelen's testimony for four comets.* Likewise Govaert Wendelen attests, in his *Teratologia Cometica* [Teratologiâ Cometicâ], pages 14, 15 and 16, that there were four comets in this year 1618.

[Margin: P. Gaſſendi Obſervatio Cometæ 1618.] *P. Gassendi's observation of the comet of 1618.* That comet appeared to the whole Earth toward the end of the year 1618 and the beginning of the following one (notes P. Gassendi in the *Philosophia Epicur.* [Philoſophiâ Epicur.], page 1150), when we were staying at Aix-en-Provence [Aquis-Sextiis] (the latitude of which city, or the elevation of the pole, is 43° 33′), where we also carried out some observations of it. It was the last days of November when a rumour spread that a white beam was appearing at sunrise; this was in fact the comet's tail, the head still lying hidden within the brightness of the rays. [Margin: Situs Cometæ.] *The position of the comet.* On the 29th, with the dawn already bright but the scales of Libra still appearing, we first saw the head itself, somewhat lower and more to the east than the line drawn between the scales [lineâ inter lanceis ductâ], and indeed nearer to the northern scale, being distant from it only by two degrees, or a little less, as far as could be judged with the naked eye.

[Margin: Capitis colòr atque magnitudo.] *The colour and size of the head.* Now this head was a star whose diameter was about three minutes. Its colour was palish; and its outline below, that is, toward the Sun and the horizon, viewed through the telescope, was quite precisely round; but above, that is, where the tail clung to it, it was turned toward the west, uneven, and as it were crinkled. [Margin: Caudæ Directio atque Longitudo.] *The direction and length of the tail.* The tail itself stretched out between Arcturus and Spica [Virginis

Spicam] over more than forty degrees; and although it was very narrow where it joined the head, it spread out so gradually that at last it ended in very nearly the breadth by which the Scales [Lances] stood apart from each other. [Margin: Deviatio extitit Auſtralis.] *There was a deviation to the south.* It did not, however, stretch out quite straight, but was bent toward the south with a certain curving. The substance of the tail (or its whiteness [albor], if you prefer) was thinner than that of the head; for it was often possible to see stars past it [præter ipſam]. [Margin: Color Caudæ.] *The colour of the tail.* It also seemed somewhat whiter, and not badly resembling the colour of the Milky Way, though it was more visible than the Milky Way. But such, indeed, was the form in which the comet presented itself at first.

[Margin: Curvitas C[?]udæ evanuit.] *The curvature of the tail [?] vanished.* On the days immediately following, however, it began to be without any curvature of the tail, continually directing the tail into the region turned away from the Sun, and showing it of almost the same size for about 20 days. From that time on the tail decreased so perceptibly that at last it merged with the head, and the whole comet appeared as nothing other than a whiteness, quite indistinct from other parts of the sky, [Margin: Cauda brevior,tum obſcurior cum capite apparuit.] *The tail appeared shorter, then dimmer, together with the head.* and of the kind that are commonly called nebulous stars [Stellæ nebuloſæ], and above all the Manger [Præſepe].

[Margin: Curſus Cometæ.] *The course of the comet.* As for its motion, it was twofold: one common to all the heavenly bodies, by which, namely, like all the stars, it completed each day an entire circuit from east to west [ab ortu in occaſum]; the other proper, by which meanwhile it was carried forward toward the north, with a certain inclination toward the west. [Margin: Motus proprius continuò langueſcebat.] *The proper motion grew continually weaker.* This proper motion, however, was unequal from day to day. For although at first it was two degrees and two-thirds [duorum Grad. cum beſſe], and around December 6 [ſub diem 6 Decemb.] it had increased by almost a whole degree, from then on it nevertheless decreased continually, so much that toward the end it was no more than very nearly two-thirds of a degree [beſſis gradus]. At last it ceased, the comet vanishing among the last stars of the Dragon's Tail [Caudæ Draconis], near the North Pole; and this around the middle of January. For the last observation with the radius was made on January 13 [die Januar. 13], when there still remained a faint and quite shapeless trace of whiteness. [Margin: Cometa pernox.] *The comet visible all night.* The comet's proper path, accordingly, ran through the middle of Libra and through Boötes [Bootem]; when it had passed his face, it began to be visible all night [pernox], that is, to become visible the whole night through. It then passed very close above his wrist [carpum], and more distantly above Helice [Helicen], or the Great Bear [Urſamve Majorem].

[Margin: Quo loco Eclipticam transgreſſus.] *At what place it crossed the ecliptic.* But so that at least this one point may be stated somewhat more precisely,

and above all for the sake of those who care to examine these matters more scrupulously: the point of the ecliptic at which the comet's path cut it seems to have been at the very end of the 14th degree of Scorpio [in ipſo fine grad. 14 Scorpii]; [Margin: Angulus inclinationis Orbitæ.] *The angle of inclination of the orbit.* and the angle of inclination of that path to the ecliptic, toward the west, seems to have been 63° 20′. So that something may also be added a little more accurately about the direction of the tail: what I said, that it was always in the region turned away from the Sun, is not to be understood of exact opposition. [Margin: Non ſemper præcisè in oppoſitum Solis Caudam direxit.] *It did not always direct its tail exactly opposite the Sun.* For whereas around the beginning of the appearance the circle drawn through the axis of the tail and the head of the comet cut the ecliptic about one sign in the order of the signs [in conſequentia], that is, beyond the Sun, that intersection afterwards went back in such a way that it ended up against the order of the signs [in antecedentia], etc. Thus far Gassendi.

[Margin: Obſervatio Wendelini Cometæ 1618.] *Wendelen's observation of the comet of 1618.* In the year 1618 [Anno 1618], thirteen days after the rising [exortu] of the third comet already mentioned (Govaert Wendelen reports in his *Teratologia Cometica*, p. 17), a fourth comet was seen on November 23 [die 23Novemb.] in Persia, not far from the Sun. [Margin: Cometa in Hiſpania obſervatus eſt.] *The comet was observed in Spain.* On the 25th that astronomer Johannes Bapt. Valentinus, already praised by me above, saw it in Spain, in the morning before sunrise, in the second decan of Scorpio [in ſecundo Decano Scorpii]; and he calls it the second comet of this month.

[Margin: Quousq; Wendelinus Cometam deprehenderit.] *Up to what time Wendelen detected the comet.* Wendelen himself observed the comet from November 29 to January 20 of the year 1619 [à 29 Novemb. ad 20 Januarii anni 1619]; on that day, however, (he says) I barely obtained its position, since it no longer was [non jam ampliùs erat], but was rather a wad of rolled-up lint [tomentum … hapſi convoluti], so that neither the head nor the tail could be properly made out, even with the telescope. I judged, however, that it then stood at 20° 30′ of Cancer, with a northern latitude of no more than 58°. Whether it disappeared on the following day, the 21st, I do not know; on the 24th nothing remained.

[Margin: Duratio.] *The duration.* This comet therefore lasted at most 60 days, at least as far as can be gathered from northern observations on this side of the equator [cis Æquatorem]. But whether it was seen somewhat earlier by the Monomotapans and the Chileans [à Monomotapis & Chilenſibus], we shall leave undecided [in medio relinquemus]. I find it credible that it appeared to them some days earlier than to the Persians and the Spaniards.

[Margin: Curſus.] *The course.* The motion of this comet, then, was from Scorpio into Cancer: from about the end of Scorpio, I say, to about 18 of Cancer [in 18 circ. Cancri], more than a third of the heavens [plus triente cœli]. At first, indeed, it was southern, by about 15 degrees of latitude [ad 15 fermè grad. latit.]; then it crossed the ecliptic at 17° 15′ of Scorpio, with an angle of inclination of

fully [admodum] 63° 50′. It did not keep this constant: for at the beginning it was smaller, and after December 23 [poſt diem 23 Decemb.] it diminished again.

[Margin: Initiò motus fuit velociſſimus & in fine tardiſſimus.] *At first the motion was very fast, and at the end very slow.* This motion was fast at the beginning, so that each day it completed about 5° in its proper course; then slower and slower, until toward the end it was thought to be stationary.

[Margin: Orbita Cometæ non fuit abſolutè arcus circuli maximi.] *The orbit of the comet was not absolutely an arc of a great circle.* To the rough judgement of the eyes [rudi quidem ſenſu oculorum], the cometary path could be judged to have described a straight line in the sky, namely a portion of a great circle; but that was not absolutely true. For it bent perceptibly back from that course [ab illo retrò ductu deflexit], as was also observed by others.

[Margin: Wendelino & Keplero Parallaxis hujus Cometæ fuit inſenſibilis.] *To Wendelen and Kepler the parallax of this comet was imperceptible.* Meanwhile no parallaxes were perceptible, neither to me nor to Kepler and other most distinguished men. From this it was established that the comet ran its course far higher than the Moon, and was not an aerial meteor, since it completed its path in the highest aether.

[Margin: Cauda nonnihil ab oppoſito Solis deflexit.] *The tail turned aside somewhat from the point opposite the Sun.* The tail was always observed by us projected into the parts turned away from the Sun; yet in such a way that, as the head hurried into the northern regions, the tail seemed to be left somewhat behind, as though unable to follow at equal speed the one running ahead [præcurrentem], just as we see the flames of lamps and torches carried rather quickly bend and, lingering, be drawn and dragged backward [retroſiùs moroſas duci ac trahi]; so the same tail, drawn in accordance with the motion of the head, [Margin: Accurata Caudæ Deſcriptio.] *An accurate description of the tail.* was curved moderately like a horn [inſtar cornu]. And on the side with which it was cleaving the aether for itself, it was quite smooth, denser and more compact; behind, however, it was looser and shaggier, and as it were feathery, so that it might not badly be compared to the spadix of a palm [palmæ ſpadice].

[Margin: Longitudo ejus.] *Its length.* Its length exceeded 56 degrees from the head, growing gradually wider, in the manner of a sunbeam let into a dark room through a small hole, which the atoms make visible;

in just that manner the comet's cone [Cometæ conus] tapered to a point at its head and was more diffuse behind, easily 5 degrees in breadth where it was broadest and farthest from the head. [Margin: Inſignis Caudæ latitudo.] *The remarkable breadth of the tail.*

[Margin: Eximius caudæ color.] *The exceptional colour of the tail.* The colour of this tail near its head was fiery and glowing red, and from time to time, with certain flashes, as it were, and sparks [fulgetris ac ſtricturis], it imitated the alternate abating and intensifying of a fire [reciprocati incendii remiſſionem atque intenſionem], [Margin: Cauda radios vibrabat frequentes.] *The tail darted*

frequent rays. just as those rods [virgæ] usually do that we sometimes see darting about at night. If ever I saw a fire, this certainly was one: but such that it then left the rest of the tail beautiful, white and shining. I say shining, because inside my study [Muſæum] I saw with these eyes a light poured from it, very dilute indeed [prædilutum quidem], but such that it cast a shadow of a finger placed between the paper and that tail, easy to make out. This tail, gradually shorter, when the comet had now reached the hand of Boötes, scarcely any of it remained, nor was there anything else to examine with the telescope but loose twigs [ſcopas diſſolutas] and little stars, and these themselves at last vanishing.

[Margin: Mira Cometæ facies Tubo detecta.] *The wonderful face of the comet revealed by the tube.* The head of the comet itself, when I first examined it with the telescope on November 29 [die 29 Novembris], I found to be like three or four shining [lucentas] [recte: lucentes] live coals [prunas] of a huge hearth [ingentis foci], kindled by a strong fire. I saw, I say, the comet as a triple globe, as it were: [Margin: Evidentiſſima alteratio in corpore Cometico deprehenſa.] *A most evident alteration detected in the body of the comet.* and indeed I noticed that these three coals changed their position somewhat in my presence [in coràm mei], as if there were someone stirring the hearth [qui focum ſcrutaretur]; and on the following days more coals were seen by me, as our coals [carbones noſtri] leap apart into more pieces once already kindled. And I congratulated myself on this very thing afterwards, when I read the most learned Cysat's comet, this one [Doctiſſimi Cyſati Cometam hunc], who observed and expressed the very same thing. Thus far Wendelen.

[Margin: Severini Longomontani Obſervatio Cometæ ejusdem.] *Severinus Longomontanus's observation of the same comet.* Severinus Longomontanus first saw the comet on November 21, Old Style [die 21 Novemb. St. V.], between 5^h and 6^h [inter hor. 5 & 6]. In apparent size, moreover, the comet was then somewhat larger than Spica [Spicâ Virginis], and it had a tail reaching, as far as the eye could judge [quoad viſum], the height of a stature not very tall [ad altitudinem ſtaturæ minùs procerioris], which it also cast quite directly into the part turned away from the Sun, which was then at 9° of Sagittarius. [Margin: Color juxta Longomontanum.] *The colour according to Longomontanus.* The colour of the head inclined toward red, so that it was, as it were, midway between the colour of Mars and that of Spica.

[Margin: Caudam immenſæ longitudinis exhibuit.] *It showed a tail of immense length.* On November 30, Old Style [Die 30 Novembr. St. V.], the comet's tail spread unusual rays beyond the zenith indeed, namely to an elongation of 104°, that is, as far as the stars in the left hand of Auriga [Aurigæ], quite directly away from the Sun, while it cast them midway between those stars and the unformed one [informem] above Orion.

On December 5 [Die 5 Decemb.] the comet's tail was directed straight at the southern star in the square of Ursa Major [in quadrato Urſæ majoris], and to the eye it reached exactly to that star. The body of the comet was somewhat dark, and the rays leaping out of the tail were sparse; the comet then appeared smaller

and redder than the star in the shoulder of Boötes. Through the optical glass [ſpecillum autem Opticum], however, the body of the comets [Cometarum] was very livid.

[Margin: Sub quo motu ductuq; Cometa inces ſerit.] *Under what motion and course the comet advanced.* What motion it had, however, according to Longomontanus's observations can be seen from the ephemeris, p. 35, *de novis cœli phænomenis* [ex Ephemeride pag. 35 de novis cœli phænomenis]. The angle of the orbit and the ecliptic was 63° 6′; and the course of this orbit indeed, or the comet's proper circle, has its north pole at 15° 15′ of Aquarius, on the surface of the sphere, with a northern latitude of 26° 54′. And therefore it cuts the ecliptic at 15° 15′ of Scorpio. From such a proper circle, however, it did not deviate much perceptibly, and that during the whole space of time in which it was observed by us, except perhaps by reason of the small parallax which it had had, concerning which there follows [de quâ ſequitur].

[Margin: Diſtantia à Terrâ.] *The distance from the Earth.* Longomontanus determined the distance of this comet from the Earth as 240 semidiameters of the Earth [S. T.], and so that it had been below the perigee of the orb of Venus, and had exceeded the greatest distance of the Moon from the Earth about four times over; much less that it had clung below the Moon and, what is more absurd still, in the highest region of the air. In this comet too, therefore, let the fiction of the Aristotelians be dismissed, except perhaps among those who would rather stubbornly oppose the truth than take anything away from their Aristotle even here.

[Margin: Proportio Cometæ ad Terram, & Lunam.] *The proportion of the comet to the Earth and the Moon.* The true diameter of the comet was 12′ 34″, of which units the diameter of the terrestrial globe [Orbis telluris] is 2°, or 120′. The proportion of the diameter of the comet to the diameter of the Earth is therefore as 377 to 3600. It is therefore established that the comet was 870 times, and a little more, smaller than the whole terrestrial globe, and that it was likewise exceeded by the body of the Moon about 20 times. Severinus Longomontanus *de novis cœli phænom.* Book X.

[Margin: Kepleri Obſervatio Cometæ 1618.] *Kepler's observation of the comet of 1618.* On November 14/24 [Die 14/24 Novembr.], at Budweis [Budouici] in Bohemia, in the winter quarters of the imperial army, Maximilianus Marsilius of the Society of Jesus, who was then present there, assured Kepler that the comet had been seen in broad daylight [clarâ luce], with head and tail very bright. Kepler himself, however, did not detect it before the 29th, as he attests on p. 58 of his *Historia Comet.* The comet, then very bright, stretched out its tail between the lines drawn from Arcturus and from Spica to the comet, nearer, however, to the latter than to the former. The colour of the tail between yellow and red. [Margin: Reciprocatio Caudæ valdè notabilis.] *A very notable alternation of the tail.* It flickered, so that at times it was long, at times short; it was spread out from the head like straight and stiff brooms [ſcopæ]. The head, viewed through the telescope, was round below, but above it faded away

into hair: the brightness greater without the telescope than through it. So great was the brightness through gaps in the clouds that, before I had collected myself, I thought I was seeing the splendour [ſplendores] of the Moon on its twenty-seventh day [Lunæ viceſimæ ſeptimæ]. I judged the tail to be about 30 degrees long [ad 30 grad. longam]; but at Rome and Vienna 58°, for it appeared inconstant. On December 9 [Die 9 Decemb.] the comet's tail was seen to be the longest of all that had shone within 150 years: [Margin: Mira Caudæ exporrectio.] *A wonderful extension of the tail.* for first it stretched above Arcturus, which Hebenstreitus too, rightly understood, notes for this day. Then it took in the unformed star [Stellam informem] under the tail of the Bear at 17° 59′ of Virgo, latitude 40° 6′ north. From there, stretched beneath the Wain [plauſtro] and widened more and more, it ran out quite clearly as far as the breast of Ursa Major near the zenith [verticem]. [Margin: Nonnunquam fulgura emicabant.] *Sometimes flashes darted out.* Indeed, if anyone looked more attentively, flashes seemed at times to dart out as far as the Charioteer [Heniochum], from the end of Libra, through Libra, Virgo, Leo and Cancer, as far as into Gemini; but the certain length, visible to the eyes of all, reached as far as the breast of the Bear, over 70 degrees of a great circle.

[Margin: Deviatio Caudæ Borealis.] *A northern deviation of the tail.* The head and tail of the comet were not quite aligned with the Sun in the same great circle, but the tail turned aside very slightly toward the north; the tail directed almost opposite from Mercury, which was before the Sun. Moreover, it was plain to the eye that the very length of the tail was bent back the same way, namely upward toward the north, so that the curvature, or arc, swelled out from its ends toward the south. [Margin: Cauda in Auſtrum extumeſcebat.] *The tail swelled out toward the south.* The Romans affirm the same. It was also, along its whole stretch, more sharply bounded and fuller on the right, thinner and more scattered on the left, toward the north. On the 16th it also began to be seen in the evening.

On the 23rd it spread its tail widely, as if toward the most northerly of the Wain [borealiſſimam Plauſtri]; and the head, viewed through the telescope [perſpicillo], appeared like a cloud. On January 7, since no tail of the comet appeared to Kepler any longer, and he could not be certain about the head either, he made an end of observing.

[Margin: Quo cœli loco reſederit Cometa.] *In what place of the heavens the comet settled.* Finally, Kepler, already named [dictus Keplerus], adds in his corollaries [conſectariis], p. 92: that at the beginning the comet was almost midway between the Sun and the Earth, ten times higher than the Moon according to the usual opinion of the Moon's height, but according to my conjectures, fully thirty times. [Margin: Quanta fueris Parallaxis.] [recte: fuerit] *How great the parallax was.* Therefore it must have produced a parallax no greater than 6′, or, according to me, 2′. At its first appearance, therefore, it was in the middle space between the orbs of Venus and Mercury. From there it crossed the whole sphere of Venus; the whole space between the orbs of Venus

and the Earth; the whole sphere of the Earth; around December 21, the whole space between the orbs of the Earth and Mars; [Margin: Cometa ſub Orbe Jovis ſubſtitit.] *The comet halted below the orb of Jupiter.* finally the whole orb of Mars, and it emerged into the space between Mars and Jupiter; yet in such a way that the perpendicular let fall from the comet at its last appearance onto the plane of the ecliptic would still fall within the region assigned to Mars.

[Margin: Immenſa Caudæ vera longitudo.] *The immense true length of the tail.* Lastly, since on December 9 it had a tail longer than its own distance from the Earth, it follows that the tail really grew in length. For at its first appearance it was much more inclined, and much nearer to the Earth (the tail, I mean, not the head itself), than on December 9. But nearer things subtend greater angles. Therefore, if the length of the tail at the beginning had been the same as on December 9, it would have been seen with a length of over 90°, since on December 9 it was 70 or 72 degrees in length. [Margin: Cauda reverà crevit.] *The tail truly grew.* But at the beginning it had no more than 23 or 30 degrees of visible length. It is therefore certain that the comet's tail grew not only in appearance but also in reality. This, moreover, agrees beautifully with that flickering which both others noticed in the comets of earlier years and I myself also noticed in this recent one; [Margin: Vnde Acontiæ dicti fuerunt.] *From which they were called Acontiae.* and it is from this phenomenon that some comets were called Acontiae by the ancients, in Latin *Jacula* [javelins], because they quiver in the manner of a javelin. Kepler in the *Cometarum Historia*.

[Margin: P. Horatii Craſſi Obſervatio Romæ habita.] *The observation of Father Horatius Crassus, made at Rome.* Father Horatius Crassus [Pater Horatius Craſſus] began to observe this comet at Rome on November 27, between the Scales of Libra [Lances Libræ], or about 4° distant from the northern Scale toward the Notapeliotes [Notapeliotem], in common speech the Scirocco, with a tail of 58 degrees. On the 30th he saw the Scale passed by the comet, with a tail at first of 23°, afterwards much longer, [Margin: In ipſâ Caudâ quaſi medulla arboris viſa eſt.] *In the tail itself something like the pith of a tree was seen.* through the middle of which, along its length, there ran a clear and distinct line, like the pith of a tree; the tail, however, curved somewhat, and stretched from the right foot of Virgo toward her knees. On the 9th, the following 10th of December [Die 9 ſequente 10 Decembr.], the comet was seen by him between Arcturus and Corona Borealis [Coronam Boream], with a very long tail, curved and swelling out toward the south, thinner and more scattered on the left toward the north, but fuller on the right. Riccioli.

[Margin: Idem Phænomenum Blancanus deprehendit.] *Blancanus detected the same phenomenon.* Josephus Blancanus [Giuseppe Biancani] saw this comet reddish in the centre, but yellowish toward the edges.

[Margin: Snellii Obſervatio.] *Snellius's observation.* Willebrordus Snellius, in his *Description* [Deſcript.] of this comet, notes that on the day it first appeared, in the morning before sunrise, it spread a glow ahead of it, so that it resembled the burning of a distant hut and rooftop; afterwards the comet itself followed,

ruddy in colour, with its rays also scattered about it in a circle, in whose recess it seemed in some way hidden [quodammodo abditus]; and this on November 27. On the day before the Kalends of December [Pridiè Calendarum Decembr.] I caught sight of it, and observed the coma stretched out toward the west about 25° in length, through whose thinness [raritatem] stars also showed through, and this not far from the comet itself; [Margin: Caudæ reciprocationem & Snellius quoque animadvertit.] *Snellius too noticed the alternation of the tail.* and it sometimes in turn took the sight of them away from us, so that the brightness and density of the tail seemed at times to be intensified and at intervals to slacken again. On the same day the comet's curl [cincinnum] faced not the Sun but Venus; after some days it so arranged itself that the tail lay stretched out directly into the region opposite the Sun.

[Margin: Curſus Cometæ juxta Sidera cæleſtia.] *The course of the comet among the heavenly stars.* Moreover, the comet itself set the path of its motion in this way: having advanced not far from the northern Scale of Libra [boreali Libræ lance], it made toward Boötes; and, leaving the star in his right leg to the left and the one in the elbow to the right, it passed between the two adjacent stars in his back. Then, leaving the one in the left shoulder also to the right, it advanced between the left hand of Boötes and the last star in the tail of Ursa Major, and passed beyond the second-to-last. At length, around the middle of January, when it stood within the Arctic circle and in the morning hours had flashed a glow of its tail, sparse indeed but long and brilliant, it was afterwards seen nowhere any longer by those seeking it in the heavens. [Margin: Cometa circa exitum totâ nocte fulſit.] *Around the end the comet shone all night.* Therefore, whereas at first it went before the rising Sun, and did so while it set its course toward the northern region of the world more swiftly day by day, at length it passed beyond our Arctic circle, which encloses within its compass the stars that never set for us, and after December 17 it shone for us here all night above the horizon, both after sunset and before sunrise.

[Margin: Habrechti Obſervatio.] *Habrecht's observation.* D. Isaac Habrecht, at Strasbourg [Argentorati], on November 30 noted in the comet a star as it were threefold, and its innermost nucleus shining like gold melted in an earthen vessel [teſta], amid the most violent fires of the cupel [capellæ]; but that nucleus was surrounded by a circle of fainter brightness, and this in turn by another circle, unsteady and twinkling. On the same day a star was seen by others in the head of the comet, like a young lady sitting in a carriage [domicella in vehiculo ſedens], as was written to Philipp Müller [Philippum Müllerum]. [Margin: In corpore Cometico dari alterationes etiam Ricciolus ſtatuit.] *Riccioli too holds that alterations occur in the cometary body.* Kepler (says Riccioli) attributed this in vain to a defect of the eyes, p. 59; for compare these observations with Father Cysat's observations made with the telescope [Teleſcopio]: you will see that it was not a trick of the eyes, [Margin: Quod à plurimis Obſervatoribus diverſisſimorumTuborum beneficio detegitur, haud eſt fallacia visûs.] *What is detected by very many observers with the help of the most varied tubes is no illusion of*

sight. as indeed very many still think, who hold that comets are eternal bodies and contend that no alterations at all occur in their bodies, against the most evident observations of more recent comets too, made by us here at Danzig.

Father Johannes Bapt. Cysat, however, observed this comet more accurately than the rest, not only as to its motion and place for each day, as may be read in chapters I and II of his *Mathem. Astronom.* [Mathem. Aſtronom.], but also as to its head and tail. [Margin: Cyſati exquiſita obſervata Cometæ 1618.] *Cysat's exquisite observations of the comet of 1618.* Since these observations were carefully made with various tubes, and moreover show things altogether singular, they deserve to be well noted; and so let us set them out briefly here as well.

[Margin: Deſcriptio Capitis Caudæq́;] *Description of the head and tail.* December 1. In apparent size the head of the comet far exceeded a star of the 1st magnitude; its light dull, pale, not twinkling, very like Saturn. [Margin: Cauda in obliquum vergebat.] *The tail inclined obliquely.* The rays of the coma flowed out from the star not perpendicularly, nor in a straight course, but in an arc curved upward and downward (more upward).

The diameter of the coma's breadth far greater than that of the head, right at B (according to the diagrams given on p. 62), where the tail of the comet also curved upward toward the zenith, with a bend sloping downward again around D, and with its rays not scattered like a broom [ſcoparum in morem], but (at least after A and D) gradually more gathered together, yet not in the end forced into a point, but having some breadth even at their furthest end. Further, as far as B the light of the coma was fairly dense, afterwards thin, so that about the middle of the tail a star of the 5th magnitude showed clearly through. [Margin: Color Cometæ.] *The colour of the comet.* The whole comet was of a light not at all inflamed or fiery, nor ruddy or lively, but languid, whitish, nebulous and dim. The length of the tail on this day was 22 degrees.

[Margin: Notabilis ſcintillatio ac fluctuatio Caudæ.] *Notable twinkling and fluctuation of the tail.* December 4. The head, or star, of the comet twinkled seldom and feebly, and as soon as that twinkling occurred, the whole coma of the comet also fluctuated at the same moment, as if gently stirred by the wind; the rays of the coma too were darted out from the head and suddenly drawn back. This fluctuation, or reciprocation, of the rays of the comet's tail was like the one that usually occurs in nocturnal chasmata [chaumatis] [recte: chaſmatis], or celestial rods [virgis cœleſtibus], thrown out from a white cloud, or also like the radiation of Venus; for its rays too do not so much twinkle as leap, or vibrate back and forth. Moreover, this darting of the rays from the head of the comet took place in such a way that in the end the coma, otherwise sharper at its extremity, was greatly widened and spread out like a broom. And this phenomenon of the comet was noticed almost whenever it was possible to view the comet; yet it was not equally notable on every day.

[Margin: Quâ die Cauda curvitatem exuit ?] *On what day did the tail lose its curvature?* December 7. The tail of the comet was no longer bent upward in so notable an arc as on the previous days, but stretched out along an almost

straight course. Arcturus was taken in by the middle rays of the comet, and there the diameter of the breadth was greatest; from there the rays, sloping more steeply, were gradually drawn together and ended more narrowly. And this hump [gibbus] was further from the head today than lately. The head of the comet again twinkled very rarely, and while the head twinkled the coma fluctuated. [Margin: Latitudo Caudæ.] *The breadth of the tail.* The greatest ordinary breadth of the tail was 2° 30′; but the extraordinary breadth, which arose from fanning [ventilatione] or fluctuation, was greater by about one degree. [Margin: Longitudo Caudæ.] *The length of the tail.* The length of the tail was a little longer than 57 degrees. Today and on the following days the stars, through the rays of the coma translucent near the head [propè caput tralucentis], were somewhat obscured by the rays of the comet, as if a cloud had been drawn over them, and so they suffered a kind of eclipse; from this it is clear that the comet was below the fixed stars.

December 8. The head twinkled seldom and feebly; the coma likewise fluctuated frequently, widened, contracted; and the hump [Gibbus] of the breadth was ordinarily 3°, in widening 4. The length of the tail was 58 degrees.

December 9. The length of the tail on this day was 75 degrees; its breadth, however, 2 degrees.

December 16. In the evening the tail still appeared in a straight course; afterwards, in the morning, it was curved with a very great bend near the zenith, around 7 in the morning [7 matut.]. [Margin: Cauda in ortu recta, in Meridie verò obliqua videbatur.] *At rising the tail was seen straight, but on the meridian oblique.* After that it was noticed that near its rising the tail of the comet stretched out almost along a straight line, but on the meridian, whether the comet was at its highest or at its lowest, it was very greatly bent and curved. The star of the comet, when lower toward the horizon, twinkled frequently, almost like the fixed stars; when higher, very rarely. It had by now also fallen off a little in size, but very greatly in brightness, so that even the light of the coma from the beginning [à principio] was brighter than the light of the head.

On December 21 the tail was only 21°, and on the 22nd shorter still. [Margin: Cauda qu[[æ/a]] hucusque decreſcebat,nunc nova incrementa accipiebat.] *The tail, which [?] had been decreasing until then, was now receiving new growth.* But on the 24th it received new growth, and when it began to fluctuate and vibrate (which happened much more frequently today than at other times), the rays were thrown out beyond their fixed limit; the tail was about 4 degrees broad.

On December 27, in the evening, the coma did not appear at all, having been extinguished by the brightness of the Moon. [Margin: Coma paullatim langueſcebat.] *The coma gradually grew faint.* From then on it diminished daily, so that at last, on January 16, the comet's coma was seen by us for the last time, very small, so that it could be made out only with the greatest difficulty. Yet on January 7 the coma could still be clearly discerned stretching to the last of Draco [ad ultimam Draconis], about 8 degrees in length.

[Margin: Cauda in æthere extitit.] *The tail stood in the aether.* Moreover, he asserts in chapter IV, proposition I, p. 66, that the coma was not in the air but far above the Moon. And in proposition II he demonstrates that the tail of the comet was always turned and stretched out directly away from the Sun.

[Margin: Vera magnitudo capitis, ejusq́; proportio ad Terram Lunamq́;.] *The true size of the head, and its proportion to the Earth and the Moon.* The true diameter of the head was 175 German miles [Mill. germ.], and the circumference of the comet 550 German miles. Hence the globe of the comet was smaller than the globe of the Earth nine hundred and fifty times [nongenties quinquagies], and smaller than the Moon twenty-two times [bis & vicies]. [Margin: Vera Longitudo Caudæ.] *The true length of the tail.* But he reports, on p. 70, that the coma was 45 semidiameters of the Earth [Semid.T.] long on December 1, 137 on December 9, 185 on December 17, and 445 semidiameters of the Earth on December 29, on which day it was longest; of such length indeed that a person could not traverse it in 100 years if he covered 10 miles a day, and that a person could have gone around the whole world [totum terrarum orbem] seventy times sooner than walk once along the length of the coma.

For the rest, as to its distance from the Earth and its place in the world, the author proves most fully in chapter III that the comet was not in the air, nor in the region of fire, but then higher than 2580 miles [Mill.], and indeed higher than 8600 miles and than the Moon itself. [Margin: Parallaxis ſenſim in dies decrevit.] *The parallax decreased gradually from day to day.* For on p. 51 he found the greatest horizontal parallax to be, for December 1, 47′ 34″; for December 9, 35′ 33″; for December 17, 26′ 3″; for December 20, 15′ 29″; for December 29, 13′ 39″; at the beginning of January not much greater than the parallax of the Sun, soon even smaller, and at last perhaps none. [Margin: Cometa,quanto intervallo à Terrâ fuerit remotus.] *At how great an interval the comet was removed from the Earth.* From this it is concluded that the comet was 71 semidiameters [Semid.] distant from the centre of the Earth, namely on December 1; on the 9th, 96 semidiameters of the Earth [S. T.]; on the 17th, 132 S. T.; on December 20, 154; on the 29th, 252 semidiameters of the Earth. So if anyone had thought of setting out from the earth straight toward the comet, he could scarcely have reached the comet in 60 years at the distance at which it stood on December 29, even if he covered 10 German miles every day.

[Margin: Mira capitis conſtitutio,Teleſcopio detecta.] *The wonderful constitution of the head, detected with the telescope.* In chapter VI he adds the following on a new and singular phenomenon of the head: On December 1 and 4 we examined the comet with diligent and prolonged inspection through an optical tube, and that a twofold one [eumq́; geminum], of which one was about 6 feet long and the other 9 or 10. The star of the comet appeared, or that more condensed light immersed in the head of the comet, which light one may from now on call the nucleus, or the core [meditullium] of the head. [Margin: Figura,color atq́ue magnitudo.] *Figure, colour and size.* This appeared with a round figure, with a continuous and compact light, though by no means

clear or brilliant; with a diameter indeed greater than any fixed star of the 1st magnitude, if that too is viewed through the tube, yet much smaller than the diameter of Jupiter, so that it was scarcely 2/3 of its diameter. This nucleus of the luminous head, moreover, of a dense but leaden and dark light, had around it on all sides a certain thinner and paler light, very like the light the Moon gives when it shines through mists or vapours, or thin clouds, with a pale border poured around it, and itself also pale [etiam ipſa pallida]; nor is that nebulous star which is seen with the tube above the Girdle of Andromeda [cingulum Andromedæ], toward the north, much unlike it [neq́ue multum abſimilis], except that this star is far dimmer than the comet. [Margin: Haud abſimilis erat Cometa nebuloſæ Stellæ in Cingulo Androme· dæ.] *The comet was not unlike the nebulous star in the Girdle of Andromeda.* And although a certain third radiance [jubar], of far more diluted and dimmer light, also surrounded that nebulous corona which encircled the nucleus, yet because that light was not denser than the light of the coma, but rather seemed to be the very outflow of the coma [ipſe Comæ profluxus], we were therefore unwilling to count it as part of the comet's head. The head therefore consisted of a core [meditullio], or a certain dense nucleus, and a crowning border [limbo], broader indeed, but of much rarer light: and the diameter of the nucleus was about 2′, the breadth [Latit.] of the border 3′, the whole diameter of the head about 8′.

[Margin: Nucleus non ſolùm crevit, ſed etiam; in partes diverſas diſſolutus eſt.] *The nucleus not only grew, but was also broken up into different parts.* On December 8 not only the whole head of the comet [totum Com. Caput], but also the solitary inner nucleus appeared twice as large as Arcturus in diameter, 3′ or 4′ (whereas on the first day it had been far smaller); and it was no longer round, but split [diffiſſus] into three or four globules of irregular shape, cohering with one another.

[Margin: Evidentiſſima mutatio atque alteratio corporis Cometici.] *A most evident change and alteration of the comet's body.* On December 17, in place of that nucleus, lately compact, a number of very small little stars [Stellulæ] now appeared, with a very dull light poured around and among them, as if shining out of a mist or a white cloud; and this was seen much more clearly and distinctly on the following day, the 18th.

On December 20 the core [meditullium] or nucleus, which on the first day had appeared as a solid and round light, appeared more plainly dissolved into many little stars, so that it was now a cluster [congeries] of a great many very small stars, of which three were seen more constantly and distinctly than the rest, and the largest of them was like a star of about the 5th magnitude. Moreover, outside that cluster of little stars, a little star also shone out in the radiance poured around [affuſo jubare]; at first it was thought to belong to the rest of the cluster, but after an hour and a half it proved to be one of the fixed stars, when it had already moved 6′ [6. m.] away outside the radiance. This little star, too, was far smaller than the smallest companion of Jupiter [minimo Jovis Comite]. [Margin: Senſibilis augmentatio corporis Cometici.]

A perceptible increase of the comet's body. Finally, the diameter of this nucleus, or now of the globe of stars, was 5 or 6′ [5 aut 6 m.], certainly notably larger than on December 1.

On December 24 both the nucleus, or globe and cluster of little stars, and the radiance itself poured around it occupied a far larger space than before, but with a much thinner and rarer light. Of the little stars lately distinguished, only one was now seen steadily; the others were indeed very many, but could not be counted distinctly, because, although they were also seen twinkling surely and often, yet they did not meet the eyes continuously and steadily all together, but intermittently, one after another, as if by leaps, in just the way that the smallest fixed stars are usually seen even with the naked eye in a very clear sky. [Margin: Nuclei rariores & inter ſe diſſipatiores corpore exiſtente ampliori cernebantur] *The nuclei were seen sparser and more scattered from one another, while the body was larger.* Finally, the individual ones were also today far more scattered from one another than on the previous days, so that the diameter of the nucleus was at least 6′, the breadth of the surrounding border 5′, the whole diameter of the head about 16′: as all of it is drawn from life [ad vivum] in the same chapter VI.

[Margin: Vt ut caput Cometæ nudo oculo decreſcere quaſi videbatur; reverà tamen ope Teleſcopii in dies creſcebat.] *However much the head of the comet seemed, as it were, to decrease to the naked eye, yet in reality, with the help of the telescope, it grew from day to day.* It should further be noted that from the first of December to the 24th the comet's head actually always grew in a certain proportion as regards its extent, whether you look at the nucleus or at the radiance poured around it; but as regards the density and clarity of its light it always became diminished, and more diluted and rarer, so that through the tube the comet's head appeared smallest on the first day and largest on December 24. Exactly the opposite happened to unaided sight [in liberâ viſione], for to it the comet's head appeared largest on December 1, and far smaller on the 24th [die 24 longè minus]; namely, because of the scattering of the little stars and the diminishing of the light. Joh. Baptista Cysat.

A true delineation of this comet, of the head as well as of the tail, is found in Book VI, page 342, and Book VIII, page 452, of the *Cometographia*.

AD 1647. [Anno Chriſti 1647.]

[Margin: In Borusſiâ Cometa anno 1647 apparuit.] *A comet appeared in Prussia in the year 1647.* In AD 1647 [A. C. 1647], even though, so far as I know, no comet was recorded by anyone, nevertheless on September 29 [die 29 Septembr.], in the evening at 8^{h} 30^{m} [veſperi hor. 8 30′], immediately after sunset, a certain haired star [Stella quædam crinita] appeared at Marienburg in Prussia [Marienburgi Prusſiæ]. We have already presented its delineation, as I then received it from a friend, as regards both its appearance and its position, in Book VIII, pages 452 and 456. [Margin: Quo loco ſubſtiterit.] *Where it stood.* It stood in the constellation of Berenice [Sidere Berenices], not very far from the left shin of Boötes [ſiniſtrâ Tibiâ Bootis], at least 5°, more or

less 10° from Arcturus, and nearly 23 or 24° from the left shoulder. [Margin: Directio Caudæ.] *The direction of the tail.* Toward this star it also directed its coma, inclining a little, however, to the right, toward the left elbow of Boötes; that is, with its point upward toward the zenith, so that it looked like an upright broom [inſtar ſcoparum erectarum]. [Margin: Facies.] *Appearance.* For since the comet was raised no more than 5 or 6° above the horizon, and this observation was made immediately after sunset, it could not have been otherwise than that it showed its tail quite upright. Its length was more or less 12°. For the rest, the tail was quite conspicuous and bright, yet in such a way that near the head, where it issued forth [in eductione], it appeared brighter and denser, and toward the end somewhat more diluted and rarer, its rays gradually spreading apart [radiis paullatim ſeſe divaricantibus]: so that at the end it looked four times, indeed five times, broader than at the head itself. Moreover, it ran out into three or four distinct rays, like a broom come apart [ſcopæ diſſolutæ]. [Margin: Capitis magnitudo.] *The size of the head.* The head was somewhat more compressed, so far as one could judge with the naked eyes, and a little smaller than Arcturus. [Margin: Cometæ locus.] *The comet's place.* At that time it was in about 8° of Libra [in 8 fermè grad. Libræ], with a northern latitude [Latitudinem Borealem] of nearly 26°, and it cast its tail into the region opposite the Sun.

[Margin: Cur ab aliis haud fuerit obſervatus ?] *Why was it not observed by others?* But what was the reason that this phenomenon was not detected by others elsewhere? I shall explain. First, so far as one can gather, a continuous inclemency of the air [aëris intempeſtas] over several days was an obstacle. Second, since the comet was elongated only 27° from the Sun, and without doubt directed its course toward the Sun, against the order of the signs [contra ſeriem Signorum], and indeed from the head of Boötes, namely, toward the ecliptic and toward Spica [Spicam Virginis], it could easily happen from this that in this way the comet vanished [interciderit] within very few days; just as, if I remember rightly, it was also seen at Marienburg [Marieburgi] for only two days. [Margin: Cometa breviſſimæ durationis.] *A comet of very short duration.* For granted that this star drew fifteen degrees, more or less, nearer to the Sun [Soli quindecim grad. plùs minùs appropinquaſſe], it would certainly not have appeared beyond two days, as is easily gathered. For the arc of visibility [Arcus enim apparitionis] of stars of the first magnitude is given by authors as not less than twelve degrees. [Margin: Cur diutiùs videri haud potuerit ?] *Why could it not be seen longer?* But the comet, as you have perceived, was smaller than Arcturus; therefore, removed to a distance of 12° from the Sun, and that in latitude, with its path [trajectoriâ] running, namely, from the northern pole of the ecliptic toward the ecliptic itself, it could by no means be seen any longer. Nor is it absurd that the comet had at that time a swifter proper daily motion of this kind, of 7 or 8°: for others at times enjoy a far more rapid one.

We have an example ready to hand in the comet of the year 1652, which at the beginning travelled nearly eleven degrees in a great circle by its own

proper motion. Hence it is again clear that the comet could, in this order [ſic ordine], have set heliacally within the space of two days at most. Book VIII, page 456, of our *Cometographia*.

AD 1652. [Anno Chriſti 1652.]

[Margin: Hevelii Obſervatio Cometæ 1652.] *Hevelius's observation of the comet of 1652.* In the year of the Christian era 1652, on Friday, December 20, New Style [St. N.], on the evening just before the winter solstice [Solſtitium brumale], at about 6^h [horâ circiter ſextâ], an unusual and very rare phenomenon, bearing the appearance of a comet, presented itself to our view here at Danzig, toward Vulturnus: [Margin: Quo loco primùm apparuerit Cometa.] *Where the comet first appeared.* and indeed not far from the star otherwise named Regel, namely the left foot of Orion, yet a little higher, to the right, near a little star [Stellulam] of the fifth magnitude that follows two others in Eridanus: so that at that time, with the star Regel just mentioned, of the first rank [primi honoris], and with that star above the foot of Orion in Eridanus, of the third magnitude, it formed a roughly equilateral triangle, and with the two upper stars of the fourth magnitude in Eridanus nearly a straight line.

[Margin: Capitis immenſa magnitudo.] *The immense size of the head.* The head was round, of rare size, scarcely any smaller than the full Moon; [Margin: Protenſio Caudæ.] *The extension of the tail.* it stretched out a remarkable tail or beard, long, of six or seven degrees, toward the Belt of Orion and Subsolanus — that is, turned away from the Sun — through the star above the foot of Orion mentioned before, which shone out very clearly in it, as near as possible up to the star in the hilt of the sword. [Margin: Color Capitis atque Caudæ.] *The colour of the head and of the tail.* The light of the head, moreover, appeared pale, and partly dull and less bright, like that of the Moon covered by a very thin little cloud; the tail had a nearly similar light, except that it was weaker still and rarer, ending in a very fine point [in tenuiſſimum terminante mucronem].

[Margin: Quo die primùm illuxerit Cometa.] *On what day the comet first shone.* You should note, however, that this comet did not come into view first of all to us, namely here at Danzig on the 20th, but already on December 18, observed by David Christiani [Davide Chriſtiani] at Giessen [Giſſæ Cattorum] and by Hilario Spinello at Padua; although, according to Joh. Kônigk, it had been sighted by the Americans as early as December 15, when it came out of Argo Navis [Argonavi]. [Margin: Quousque duraverit.] *How long it lasted.* It lasted about 20 or 22 days. For it was observed by us from December 20 until January 10 of the year 1653: as our observations show.

[Margin: Curſus.] *Course.* At the beginning, namely on December 20, it was found in about 9° of Gemini with a southern latitude of about 31°; at the end, however, in about 20° of Taurus with a northern latitude of nearly 32°; so that it advanced continuously with a retrograde motion, namely from the more southern parts of the sky to the northern ones; namely through Lepus,

the foot of Orion, Taurus at the Pleiades, as far as Perseus; not in a straight line but obliquely, namely from Hyper-Euronotus to Hypocircius.

As regards its course, we have shown in Book I of the *Cometographia* [Lib. I Cometograph.] that the comet had not only a proper motion in a peculiar orbit, describing a section of a circle that is almost a great circle, at a certain angle of inclination to the ecliptic and the equator, though one continuously variable; but also an altogether unequal motion from the beginning of the apparition up to its end. [Margin: Motus fuit ſumme regularis.] *The motion was supremely regular.* Yet this motion, however entirely different it was on each single day, was not on that account irregular; but by continually decreasing it kept the greatest regularity within that inequality. [Margin: Motûs velocitas.] *The speed of the motion.* At the start it completed 11° 16′ in one day; at the end, however, scarcely 30′ [vix triginta minuta];

yet it did not become stationary [Stationarius], nor direct with respect to the ecliptic [quà Eclipticam]. [Margin: Quantum ſpatium cœl[[i/s]] pervagatus ſit.] *How much space of the sky [?] it traversed.* Over its whole duration, therefore, namely in the space of 20 days, it traversed 65° 51′. The angle between the orbit and the ecliptic was 73° 56′ 52″ at its first rising, with the node in 28° 31′ 25″ of Taurus; at its departure [in exceſſu] this angle was found [deprhenſus eſt] [recte: deprehenſus eſt] to be 75° 3′, with the node in 29° 7′ 19″ of Taurus. [Margin: Angulus inclinationis.] *The angle of inclination.* The angle between the orbit and the equator, on the other hand, was 63° 0′ 44″ at the beginning, with the node in 66° 53′ 29″, and at the last 64° 18′, with the node lying in 67° 8′ 13″. [Margin: Quando Ec'ipticam tranſierit.] [recte: Eclipticam] *When it crossed the ecliptic.* The comet crossed the equator on December 21 at 3^{h} 13^{m} 47^{s} in the afternoon [hor. pom. 3 13′ 47″], but the ecliptic on December 24 at 5^{h} 21^{m} 11^{s} in the morning [manè horâ 5 21′ 11″].

[Margin: De Parallaxi atque Diſtantiâ hujus Cometæ à Terrâ.] *On the parallax and the distance of this comet from the Earth.* As for its distance from the Earth, it is most certain, as we have proved at length in Books II, III and IV of the *Cometographia* [Lib.II, III, & IV Cometogr.], that this comet stood in the highest aether, even when it was nearest to the Earth. For the greatest parallax that could be found was not greater than 31′ 15″, so that it was never found nearer than 110 semidiameters of the Earth [Semid. T.]. And since it went on from day to day to more remote distances, at last on January 12 its interval from the Earth grew to 22,509 semidiameters of the Earth [S. T.]. For at that time the parallax had already decreased to 9″, as we clearly demonstrated in Book IV, in the parallactic table [Tab. Parallacticâ], and likewise in Book V of the *Cometographia*. [Margin: Cometa continuo à Terrâ diſcesſit, ad Orbem usque Jovis.] *The comet continually receded from the Earth, as far as the orb of Jupiter.* It is therefore beyond doubt that the comet not only stood twice as high as the Moon [Lunâ duplo altiorem] even at its nearer distance, but that on December 30 it had already reached the orb of Venus; on January 4 it had already passed beyond the Sun; on January 8 it had already gone beyond the orb of Mars;

and on January 12 it had crossed almost the whole orb of Jupiter, according to Kepler's distance of the Sun from the Earth.

[Margin: Magnitudo Capitis.] *The size of the head.* Concerning the apparent and the true size of the head [De viſâ & verâ magnitudine Capitis], its light and its colour, I would have you know this, kind reader: at the beginning, on December 20, the comet equalled the Moon in apparent diameter at least [minimùm], without any spurious light; and at that time it gave back an even light, not flowing out around the limb [limbum] but marking out a precise circumference; so much so that to the naked eyes it could not be perceived otherwise than as having, in the middle, no livelier light, apart from certain nuclei, like spots, visible with the telescope alone: as you will soon understand more fully.

[Margin: Color.] *Colour.* It showed a colour somewhat darkish, dusky and gloomy, not as lively as that of the fixed stars and the planets, but paler still than the light of the Moon itself. Yet it did not show exactly the same colour at all times. Indeed [Quemadmodùm], the matter becomes still clearer from the observations of various astronomers.

[Margin: Wendelini Obſervatio hujus Cometæ.] *Wendelen's observation of this comet.* Govaert Wendelen in the *Teretologia Cometica*, page 25: *On December 20, at Tournai* [Tornaci] (he says), *in the eighth hour after noon, my household* [meâ familiâ], *going into the neighbourhood on domestic business, noticed in the sky an unusual but dim light, as if of the Moon hidden behind a cloud and shining faintly, etc.* Likewise pages 26 and 27: *On the 21st, at* 8^h *in the evening* [hor. 8 veſp.], *I see* (he says) *near the Shield of Orion* [Orionis Clypeum] *an unusual light, which was indeed larger than any of the nebulous stars, but shone more faintly, with a pale and boxwood colour* [buxeo], *gloomy and dark. And since I knew that there was no nebulous star in that place, by fixing my gaze more closely I noticed that it was in truth a comet, but of a different kind from those which I have listed and remembered having observed.*

Its size (take note) *was such as either to equal or to exceed the disc of the Moon, etc.* [Margin: Cometa magnitudine Lunam ex[[c/e]]eſſit.] *The comet exceeded [?] the Moon in size. The younger of my nieces, who the day before* (as I related above) *had seen this new prodigy in the neighbourhood* [juxta viciniam], *added that it had then been much larger and fuller in brightness, and also of a livelier colour; whereas now it was pale, and of a boxwood colour. Those who were present affirmed the same.*

[Margin: Cornelii Malvætici Obſervatio.] *Cornelius Malvæticus's observation.* Cornelius Malvæticus at Bologna [Bononiæ]: *At the first hour of the night* (by Italian hours [juxta hor. Italicam], he says) *on December 21 a comet was found around the stars of the Shield of Orion* [Clypei Orionis], *nebulous and of remarkable size; its diameter was nearly equal to the semidiameter of the Moon. Through the telescope the whole body did not appear to be of the same character. For in the middle it showed a whitish disc, as the Moon is seen among clouds; and it was of as great a size as the Moon itself appears to the naked eye, and even somewhat larger.*

[Margin: D. [[C/c]]hriſtiani Obſervatio.] *D. Christiani's observation.* D. David Christiani [D. David Chriſtianus], at Giessen [Gisſæ Cattorum], on December 8 Old Style [Styl. Vet.]: *I noticed* (he writes on page 8) *a certain new phenomenon and an adventitious star* [Stellam adſcititiam], *endowed with a dark, rare and nebulous light, which in its whole form was very like that ring* [gyro], *or heap and cluster of stars, which they call the Pleiades* [Plejades]; *except that from the beginning, around this day and some following days, it appeared somewhat larger than this very ring* (note: for the Pleiades themselves occupy a space of almost one degree in the sky); *so that if anyone were to look more carefully at its very extremities, in apparent size it would very nearly equal a small orb containing a span* [ſpithamam] *in diameter, although, because of the gloomy aspect of its dull light, it by no means presented itself to the eyes as clearly as the planets or the fixed stars, coeval with the world* [mundi coæva].

[Margin: Obſervatio Alepi habita, cum noſtrà egregiè conſentit.] *The observation made at Aleppo agrees excellently with ours.* Basirius, an Englishman, Doctor of Medicine [Medicinæ D.] at Aleppo [Alepi], observed the same comet with exactly the same appearance. *For on the twentieth day of December of the year 1652* (he reports), *at around* 8^h *in the evening* [hor. circ. 8 veſp.], *in the city of Aleppo* [Alep], *which is in the province of Commagene* [Comagenæ] *in the Kingdom of Syria, a very remarkable comet was seen, and of unusual size, for it nearly equalled the Moon;* [Margin: Cometa haud minor Lunâ.] *The comet not smaller than the Moon. somewhat pale in colour, resembling a little cloud lit by the Sun, roundish, yet pointed toward the east and as it were bearded. It was first seen in the sign of Gemini near Regel, or the foot of Orion, at the very beginning of the river Eridanus, making an equilateral triangle with the Regel just named and with the star that is at the right leg of the same Orion.*

From these observations of such widely differing authors, anyone can see clearly [quis non perſpicit] that the comet not only came fully up to the size of the full Moon, but even exceeded it somewhat, or nearly so [ferè aliquantò].

[Margin: Apparens Diameter [[C/c]]ometæ quotidiè decrevit.] *The apparent diameter of the comet decreased daily.* Yet it did not keep this size constantly, but as time went on it diminished from day to day in its apparent diameter. For at the beginning that diameter was observed to be at least 30′ [30 minut.], but at the end only 3′ 30″, as is clear from page 327 of Book VI of the *Cometographia* [Lib. VI, Cometogr.]. Likewise, in light and colour the comet gradually became darker, paler and gloomier, so much so that on January 8 it could scarcely be seen any longer with the naked eye.

[Margin: In corpore Comitico diverſi nuclei conſpecti ſunt.] [recte: Cometico] *Various nuclei were seen in the body of the comet.* On December 27 I examined the body of the comet through the telescope, and in it, toward the tail on the left, I detected four or five small bodies, or nuclei, somewhat denser than the rest of the body, of which two appeared a little larger than the remaining three:

although various other, very minute ones still presented themselves here and there, scattered over the disc, yet almost eluding the eye; and so it was not possible to distinguish them properly and to draw them. Toward the right, however, we noticed a winding and twisting light, much brighter than the rest of the whole body, just as if it were a heap of many very minute small bodies. This light, however, was not as intense and lively as that of the other fixed stars, or of the planets, but a little duller.

On January 10, when it was observed for the last time, we found by the same aid of the telescope that it had become still further attenuated in head and light; yet in size it far surpassed the fixed stars, though they were of the first rank. [Margin: Materiâ paullatim disgregatâ Caput tenuius ac rarius redditum eſt.] *As the matter was gradually dispersed, the head was made thinner and rarer.* The little body, however, was extremely rare, so much so that no further nuclei appeared in it. For the matter seemed nothing but scattered and extremely diluted, like a shadow, with certain fissures and passages interspersed; all of which, however, were made out with difficulty, and equally so with accuracy [difficulter æque accuratè], as usually happens with spots that are on the very point of perishing.

[Margin: Similes diverſos nucleos ſeu Stellulas & alii deprehenderunt.] *Others too detected similar various nuclei, or little stars.* Those little stars, or nuclei, visible in the disc of the comet, were noticed not only by me but also by others with me. For Wendelen is the authority, in his *Teretologia Cometica* [Teretologiâ Com.], page 25, that the Jesuit Fathers at Mantua [Mantuæ], namely, observed several stars in the comet. He himself also, *at the eighth hour* (he says), *at the lower part of the Shield of Orion, forming a triangle with the seventh and the eighth star in it, and as it were the boss of that Shield, somewhat nearer to the eighth star than to the seventh: but when I go down into the study* [Muſæum]*, get the telescope ready and examine for some time the whole body of that star, I see in it a good many very minute little stars, and among them one larger than the others and oblong, in the middle of the rest. You would have said it was a hearth showing, after its wood had burned away, its remaining ashes, with live coals and sparks mixed in among them.* [Margin: Wendelinus teſtatur etiam in Cometa 1618 diverſitates reperiſſe.] *Wendelen also testifies that he found diversities in the comet of 1618. In short, the appearance seemed to me the same as that of the earlier comet seen in the year 1618 in the hand of Boötes.*

[Margin: Coloniæ quoque nucleos conſpexerunt.] *At Cologne too they saw nuclei.* These observations of ours on the small bodies and nuclei seen in the cometary disc are confirmed in no small measure by those of Cologne and of Münster [Colonienſes & Monaſterienſes], who assert *that this comet of 1652, like others in the past, was composed of bright particles like little stars, in the manner of a larger star immersed in a thin cloud, producing a halo that grew thinner and thinner from the centre; and that this itself* (they say) *is why its diameter could hardly be measured exactly. At first, however, it was larger, of 5 degrees; afterwards, becoming gradually smaller, it decreased to nearly 3 digits, and fewer.* Likewise, from the observation of the distinguished [Cl.] Ismaël Boulliau published at Paris, page 11, we learn that differences of parts existed in the cometary body. [Margin:

Teſtimonium Cl.Bullialdi de diverſitate materiæ Cometicæ.] *The testimony of the distinguished Boulliau on the diversity of the cometary matter.* For *when a telescope was applied* (he says) *the mass of the body* (the comet) *appeared far larger than Venus, yet not round but rather oblong; the inner part of the body was less white and shining in the telescope than it was seen with the naked eyes, but somewhat dusky. Certain faint scintillations as of little stars were seen; it seemed to spread a very thin whitish light toward the east* [ortum versùs]*, but a very short one.*

[Margin: An hæc ſomnia ſint ? Tu ipſe judices, rogo.] *Are these dreams? Judge for yourself, I ask you.* From this it is more than sufficiently clear that it is not mere dreams, nor fictions, nor illusions of telescopes (as some imagine), that very diverse nuclei, and a matter that alters itself from day to day, are often found in comets.

[Margin: Vera magnitudo Capitis.] *The true size of the head.* Now the true diameter of this comet, given its apparent diameter of 30′, was 825 German miles [Mill. germ.] on December 20. It therefore displayed a remarkable size, so much so that if anyone had proposed to go around it, then even supposing he covered 10 miles a day, 259 days would nevertheless be spent in completing that whole journey. [Margin: Corpus Cometicum reverà crevit.] *The body of the comet actually grew.* Yet the comet did not keep this true size for its whole duration, but changed it gradually: not, indeed, by diminishing it in proportion to the apparent diameter, but by increasing it, by reason of the growing intervals [Intervallorum] of the comet from the Earth. Hence on January 12 the true diameter was 19,640 German miles, that is, nearly 24 times larger than it was at the beginning, on December 20, as can be read in Book VI, page 337 of the *Cometographia* [Lib. VI, pag. 337 Cometogr.].

[Margin: Caudæ Deſcriptio.] *Description of the tail.* Let us now come to the appearance [faciem] of the tail. On December 18, at its very beginning, it appeared with a shorter tail and as it were bearded, as David Christiani testifies: *It stretched out a train* [Syrma] *or rays toward the east, a span* [Spithamæ] *in length, to the sight* [quoad viſum]. And as Hilario Spinello reports: *It extended a small tail toward the eastern part, somewhat narrowed at the end, of a length of about three diameters of the Moon.* On the 19th the tail appeared nearly the same, as the observation of Padua [Paduenſis] and of Cologne [Colonienſis] testifies. But on the 20th, in the evening, its length was found to be 7°; its breadth at its outlet [in eductione] equalled the head; it advanced in a straight course and ended in a sharp point like a pyramid or a column; it was whitish and somewhat dark, thin, and furnished with no diverging rays, or shaggy ones, just as we drew it under number 47, Book VIII, page 453. On the 23rd, however, the comet displayed a somewhat shorter tail, stretched out about 5° toward the eye of Taurus [oculum Tauri], and also a dark leaden hue [livorem] and a feeble light. [Margin: Cauda nunc longior, nunc brevior viſa eſt.] *The tail seemed now longer, now shorter.* On December 25 the length of the tail was found scarcely to exceed 1½°; by the 27th it had gradually increased again. Then, in turn, it diminished up to December 31, on which day scarcely any trace of it was

observed. On January 1 of the year 1653, however, the coma [Coma] did indeed meet the eyes again, but it gave back a very dull light, so that on January 3 it was even nearly 2° long; on January 4 it was again shorter and darker; [Margin: Cometa ultimò crines omnes deperdidit.] *At the end the comet lost all its hair.* but on the 7th and 8th the comet seemed stripped of its mane [jubâ] altogether.

[Margin: Cauda ſemper ſub deviatione aliquâ ad partem Soli obverſam protenſa fuit.] *The tail was always stretched out with some deviation toward the part turned toward the Sun.* Moreover [prætererea] [recte: præterea], it did not continually cast its tail entirely in the opposite direction, but with a certain deviation, and that a variable one, now to the south, now to the north, sometimes at an angle of deviation now of 18°, now also smaller, as is clear from the table in Book VIII, page 489 of the *Cometographia* [Lib. VIII, pag. 489 Cometog.].

[Margin: Vera longitudo Caudæ perpetuò aucta eſt.] *The true length of the tail was continually increased.* The true length of the tail grew continually, though without a fixed law: at the beginning it was in fact 3440 German miles, and at the end, on January 4, 165,000, as was demonstrated on page 533.

[Margin: De motu vero in Trajectoriâ.] *On the true motion in the path.* Finally, I consider it worthwhile that we likewise review briefly along what course [ductu] of its path, and with what true motion in it, the comet travelled during the whole time of its duration. Here I would have you know first that, in our opinion, the comet completed its journey in a nearly straight line, so that the trace of its path [veſtigium Trajectorium] cut the annual orbit in 18° 30′ of Gemini; [Margin: Situs Trajectoriæ.] *The situation of the path.* and formed with the line of sight [viſoriâ] on December 26 an angle of 100° 45′; while the path itself made with its trace on the plane of the ecliptic an angle of 43° 30′, the longitude of the path being 5° 9′ of Virgo on December 9. The path therefore ran below the intersections of the lines of sight [ſectiones viſoriarum] drawn from the Earth, and outside the annual orbit; [Margin: Motus in Trajectoriâ verus.] *The true motion in the path.* and in it the comet, at the beginning, on December 18, covered 94 semidiameters of the Earth by its own native motion, namely in the space of 24 hours, but at the end only 72 semidiameters of the Earth; so that throughout its whole duration it had a true motion that was continually slower, yet most regular and supremely proportioned. These are the things we have thought fit to mention briefly in this place; if anyone wants more particular details, let him go to our *Cometographia* itself.

AD 1661. [Anno Chriſti 1661.]

[Margin: Hevelii Obſervatio Cometæ 1661.] *Hevelius's observation of the comet of 1661.* In the year 1661 from the birth of Christ [Anno à nato Chriſto 1661], on February 3, in the morning at 5^{h} 47^{m} [hor. 5 47′], toward Subsolanus, a comet shone forth below Delphinus, between the heads of Aquila and Equuleus, in 10° 5′ of Aquarius and in northern latitude 22° 3′. [Margin: Capitis figura, color, atque magnitudo.] *The shape, colour and size of the head.* The head was

round, of a yellowish colour, bright and conspicuous, yet it was endowed with no twinkling light. With the aid of the telescope it showed in the centre [meditullio] of the head a reddish nucleus, nearly equal to Jupiter itself, which, however, a far more diluted and thinner matter surrounded. [Margin: Caudæ longitudo atque directio.] *The length and direction of the tail.* It stretched out a remarkable tail of six degrees, more or less, toward Delphinus, more compressed at its outlet [in eductione] at the head than about its extremity. For it gradually diverged, so that at the end it appeared with spreading and shaggy rays.

[Margin: Duratio.] *Duration.* The comet was observed by us here at Danzig for 53 whole days, namely from February 3 (although *at the port of Pillau* [in Portu Pillavienſi] *it had already been detected on February 2*) up to March 28, on which day it stood in 13° of Capricorn and in northern latitude 26° 10′; so that in its whole course it traversed no more than 25° 47′ in its orbit. [Margin: Curſus.] *Course.* Its course was from Eurus to Zephyrus, namely through the head, the neck and the greater part of the lower wing of Aquila, in a track nearly parallel to the ecliptic and the equator, and retrograde; [Margin: Cometa ſub orbitâ apparenti valdè obliquâ incesſit.] *The comet moved under a very oblique apparent orbit.* yet it by no means moved under a great circle, but under a line entirely curved, or rather *comicâ*[696]. For the variation of the angle of inclination of the orbit with respect to the ecliptic and the equator was found to reach 16, indeed 18° [ad 16 imò 18 grad.], while that of the nodes reached 27°. Nevertheless it performed a most regular motion; [Margin: Motus apparens proprius.] *The proper apparent motion.* although even at the very beginning, when it was swiftest, it traversed no more than 1° 34′; for near its exit it completed only 6′ in one day, and 15″ in one hour.

For the rest, this comet likewise had its seat in the highest aether, although it was not removed from the Earth by an equal interval at all times. [Margin: Cometæ pa rallaxis, atque Diſtantia à Terrâ.] *The comet's parallax and distance from the Earth.* For the parallax was 1′ 43″ at the beginning, but at the end no more than 23″; that is, the comet was at first 2000 semidiameters of the Earth from the Earth [Tellure], but at its exit 9000 semidiameters of the Earth; so that at first it was much nearer to us, but afterwards far more remote, and so from day to day it went on to higher regions. [Margin: Cometa in ſummo extitit æthere.] *The comet was in the highest aether.* Not only, therefore, was the comet [Cometâ] 33 times more remote than the Moon from its first sighting, but it dwelt in the orb of Mercury; at the end, in April [ultimò Aprilis], it was not lower than the Sun, and about its last appearance it was found in the outermost part of the orb of Mars.

You have already learned at the beginning with what light and colour the head was endowed, and that it had a single nucleus in its centre. It was, however, larger on February 5, and brighter, of a golden colour, yet it displayed a duller light than the other stars [lumen tamen triſtius, quam reliquarum Stellarum

[696]so printed; perhaps for conicâ, conic

præ ſe ferebat]. [Margin: Evidentisſima alteratio in Capite Cometæ deprehenſa eſt.] *A most evident alteration was detected in the head of the comet.* But that single nucleus had already been cut apart into different parts. On February 6 the disc of the comet had partly decreased, and most of the nuclei were also smaller. Of these, one, in the lower part of the disc toward the left, appeared [extitit] much denser and brighter than all the rest, with a round body, like some very bright little star; other matter, as always, entirely surrounded these nuclei. On the following day that brighter nucleus already appeared partly darker. Then the head gradually decreased in size, and the nuclei were seen blunter and more confused. [Margin: Cometa non abſolutam præ ſe ferebat rotunditatem.] *The comet did not display a perfect roundness.* Nevertheless on March 2 the comet, still fairly conspicuous, was a few minutes in diameter in size; but it was not entirely round, since it appeared torn and scattered all round. Lastly, on March 28, namely with the aid of the tube [Tubi ſcilicet beneficio], the comet was noticed to be very pale and very thin, and above all very dispersed in respect of its matter, so that no nuclei at all could be made out separately [diſcretè], although the size of its disc had decreased little: as we have carefully sketched in Book VII, page 17 of the *Cometographia* [Lib VII, pag. 17 Cometographiæ].

We have already said with what appearance the tail of the comet was seen on the first day of its apparition. On the 5th [Die 5] the tail was only 4°; but on February 6 it was a little sharper, paler and darker; moreover on this day it darted frequent rays, so that it was observed now shorter, now longer; but through the tube [per Tubum] it went thinner and almost whiter between two little stars situated at the head of Aquila. [Margin: Caudæ reciprocatio.] *The reciprocation of the tail.* On the 7th it projected its tail, of about three degrees, straight upward from the horizon. On February 10 the coma [Coma] appeared still shorter, thinner and sharper; at its tip the neck or head of Aquila, otherwise a bright little star, shone out. From then until February 14 the comet showed scarcely a thin trace of its tail because of the brightness of the Moon; but on the 17th it again put it out brighter, toward the Bright Star of Aquila [Lucidam Aquilæ]. [Margin: Cometa Caudæ expers.] *The comet without a tail.* By contrast, from February 20 to the 27th it seemed to be entirely deprived of any tail. On March 2, in turn, we detected with the telescope [Teleſcopio], quite distinctly, the tail, about a degree long, inclining toward the upper of the unformed stars [ſuperiorem informium] near the right shoulder of Serpentarius. But from this time until February 28 [ad 28 Febr.] it was found to be completely stripped of its coma.

Yet it did not continually direct this tail precisely toward the part opposite the Sun, but with a certain deviation, and one indeed perpetually variable, now northern, now southern. [Margin: A Solis oppoſito Cauda deflexit.] *The tail turned aside from the Sun's opposite.* For at the beginning the northern deviation was about 8° [ad 8 circ. grad.]; but at the end it grew to 12°, and indeed toward the south [Auſtrum]: as has been shown in its place in Book X [Lib. X].

Moreover, although this comet moved under a very curved apparent orbit, indeed an almost conic one, [Margin: Trajectoriæ Situs.] *The position of the path.* yet in reality it led its course in a nearly straight path; and indeed for almost the whole time of its apparition, within the annual orbit, under an angle of inclination of the path and the trace [Veſtigii] of about 24°, though one most variable in succession. [Margin: Qualis fuerit motus. verus in Trajectoriâ.] *What the true motion in the path was.* The true daily motion of the comet in its track [tramite], or path, was unequal indeed, but supremely regular: namely on the first days 239 semidiameters of the Earth, but at the end only 140 semidiameters of the Earth; so that from the very beginning it was in fact very swift, and indeed far more rapid than all the other comets whose observations it has been granted us to investigate.

[Margin: Quantum c[[æ/œ]]li ſpatium Cometa reverà emenſus ſit.] *How much space of the sky the comet in fact travelled across.* However that may be, in its whole duration it ranged over no more than 11,953 semidiameters of the Earth [Semid. T.], according to our hypothesis.

[Margin: Obſervatio Cometæ 1661 Olmitii habita.] *Observation of the comet of 1661 made at Olomouc.* At Vienna and Olomouc [Olmitii], the comet of 1661 rose on February 8 in the morning at $3^h\ 4^m$ [hor. 3 4′], near the head of Aquila, so that it stretched out its rather thin [ſubtenuem] tail toward Delphinus. If you look at the body of this comet, it was of a reddish [ſubruffo] and pale colour, not exceeding the figure of a star of the third magnitude; its course or motion, as could be noticed over 2 hours and more, was always at an equal distance from Aquila.

On February 9 it rose at the same place at $3^h\ 3^m$ [hor. 3 3′], about one degree nearer to Aquila than the day before, so that it seemed to stand at its head [ipſius capiti]. The colour of the comet was not as pale and bright as the day before, but somewhat brighter; [Margin: Caudam ſurſum exporrexit.] *It stretched its tail upward.* moreover it no longer extended its tail toward Delphinus, but straight out (or rather upward). [Margin: Corpus Cometicum ope Teleſcopii longè major apparuit.] *With the aid of the telescope the comet's body appeared far larger.* Although to the eye the body does not exceed a star of the third magnitude, yet when I looked at it (says the observer) through a tube [Tubum] of 8 feet [qui 8 ped. eſt], I noticed that its body was twice as large as that of Jupiter [Jovis], which nevertheless appears to me round like a small sun; and that the tail gradually tapered into a cone.

AD 1664. [Anno Chriſti 1664.]

[Margin: Quo tempore Cometa Dantiſci ab Autore conſpectus fuerit.] *When the comet was sighted at Danzig by the author.* In AD 1664 [A.C. 1664], on December 14, New Style [St. N.], an exceptional comet was observed at Danzig [Gedani], in the morning at about the fifth hour, in 8° of Libra [in 8 grad. Libræ], and in a southern latitude of about 22° [22° grad. ferè]. [Margin: Quali & quanto capite initiò illuxerit.] *With what kind and what size of head it shone at first.*

The head was quite conspicuous, of a yellowish colour, and of a weaker and somewhat duller light, nowhere so vivid and splendid as that of the other stars and planets, as usually happens with comets. In its centre [meditullio] a certain brighter light, of three or four minutes in diameter, appeared to the naked eye, surrounded by another darker and thinner light, or head of hair [capillitio], whose whole diameter was estimated at about 12′. [Margin: Quænam initiò in ipſo corpore Teleſcopio detecta ſint.] *What was detected at first in the body itself by the telescope.* But when the head was examined, we noticed with an excellent and very long telescope [Teleſcopio] that the core [meditullium] of the body consisted not of a single brighter nucleus but of very many particles, or corpuscles, some denser and brighter, others thinner and darker, larger and smaller, with other, subtler matter of differing density scattered among them besides. [Margin: Caput paullatim crevit, condenſante materiâ tenuiori.] *The head grew little by little, the thinner matter condensing.* This head, however, was seen [cernebantur] to grow gradually, little by little, and its matter, together with the thinner nuclei, to condense more and more (with the aid, that is, of the telescope [Tuboſpicilli]): for that more diluted matter, scattered here and there at the sides, was as it were gathered together and packed close; [Margin: Inſignis & clariſſimus nucleus in ipſo capite deprehenſus eſt.] *An outstanding and very bright nucleus was found in the head itself.* so much so that on December 29 the head itself, with its head of hair, was found to be 24′, and in its centre a very bright and very dense nucleus, of an almost fiery colour, which was surrounded by other matter of differing density, with smaller nuclei mixed in. [Margin: Motus hujus nuclei.] *The motion of this nucleus.* On the following days, however, this larger nucleus, which had clung almost to the centre, gradually moved off toward the periphery. Then, namely at the beginning of January, this same more solid nucleus, together with the remaining denser matter of the head, began little by little to break apart, dissolve and thin out, and the head itself no less to diminish in appearance, so that on January 6 it seemed scarcely 8′. [Margin: Caput Cometæ quoad apparentiam decrevit.] *The comet's head decreased in appearance.* Moreover, just as it decreased from day to day, so the comet appeared duller and paler in light and colour. [Margin: A rotunditate evidenter defecit.] *It clearly fell short of roundness.* But on January 22 the disc of the comet displayed by no means a perfect roundness, but a rough and torn one, with points jutting out slightly here and there.

[Margin: Magnitudo.] *Size.* On this day its size, in comparison with the lunar spots, equalled no more than 6′, and on February 2 no more than 3′. Then the interior matter was far rarer, almost all those denser nuclei having been obliterated; and so, with the progress of time, more and more, up to its last appearance, the head was observed to be thinner, paler and darker. We drew this diversity and alteration of the nuclei from life in 28 figures [iconiſmis] shown in our *Prodromus*. [Margin: Proportio veræ magnitudinis Cometæ ad Terram.] *The ratio of the comet's true size to the Earth.* The true size of the head of this comet, together with its head of hair [capillitio], was at the beginning

almost six times greater than the Earth's diameter; then it diminished little by little up to January 6; nevertheless it was still larger than the Earth's diameter by three times and somewhat more [triplo, & quod excurrit]. Afterwards it increased again, up to February 4: on that day the comet's true diameter exceeded the Earth's diameter fourfold and more.

[Margin: Quâ Caudâ fuerit præditus, & quam plagam versùs eam projecerit.] *What kind of tail it was furnished with, and toward which region it cast it.* If you look at the tail: on December 14, namely, it displayed a notable and outstanding one, of 14°, and quite bright, though less so than the body itself. Just as the tail grew thinner little by little, beginning from the head, so toward its extremity it spread out more and more, stretching itself along the line of direction [lineâ Directionis] toward Favonius [Favonium], that is, toward Crater, between the star called the base of Crater and the more northern one below Crater, though nearer the base. On the following days it appeared now shorter, now longer. [Margin: Cauda nonnihil fuit incurvata.] *The tail was somewhat curved.* On December 21, however, it presented a remarkable appearance: for not only did it run out in length to 22° and in breadth to almost 2°, but around its tip it partly curved, and indeed with its concavity downward, that is, toward the horizon, and its convexity upward; although on the very next day it was stretched out quite straight again.

[Margin: Idem phænomenum & alii alibi deprehenderunt.] *Others elsewhere also detected the same phenomenon.* Other observers too detected this curvature of the tail on about the same days. For at Graz [Græcii], as P. Balthasar Moretus [P. Balthaſ. Moretus] testifies, the tail was observed to be *swollen in the manner of a spinning top [more turbinis], and pointed at both ends in the form of a rhombus.* [Margin: P. Petiti Obſervatio.] *P. Petit's observation.* Likewise at Paris, by the distinguished Petit [Pierre Petit]: [French] *There were* (he says in his *Dissertation on Comets*, page 290) *fewer rays in front of the head than at the sides; and those that were behind were continuous, and formed a long tail, which went on widening a little and even curving, and bending toward the horizon. This tail was a good ten degrees or so in length, and a half [un demy] in breadth at the end:*

On the morning of December 28 a great and unexpected change befell the tail; for it no longer stretched toward Favonius or Corus [Corum], as had been noticed up to then, [Margin: Jubar inſtar Caudæ Pavonis ſursùm omninò exponebatur.] *The radiance was put out entirely upward, like the tail of a peacock.* but stretched entirely toward the north, that is, upward. Moreover it was very broad and spread out, about 7° in length, like the tail of a peacock [inſtar Caudæ Pavonis]; in its middle the bright preceding star in the stern of the Ship [in puppi Navis præcedens] shone out. [Margin: Inclinatio Comæ.] *The inclination of the coma.* From December 29, although the comet displayed a rather short coma, it nevertheless now began to incline it toward the east [ortum], and indeed more and more from day to day, according as it was at the same time made successively longer in that direction [versùs]. [Margin: Initiò Caudam Occaſum, nunc verò Ortum versùs exporrexit.] *At first it stretched its tail toward*

the west, but now toward the east. At last, on the evening of January 5, it put out its tail toward Eurus [Eurum] in turn [rursùs], that is, into the region of the sky opposite to that of its first apparition, to the fourth in the Shield of Orion [Clypeo Orionis]. It also kept this direction of the tail toward the east [Ortum] constantly from then on, right up to its end;

but not its length likewise [ſed longitudinem non item]. For up to the middle of January it extended its radiance [jubar] to 15, indeed about 20°; afterwards, however, it gradually thinned out and became sparser and darker. [Margin: Cauda per intervalla reviruit.] *The tail revived at intervals.* On the 26th, 27th and 28th [Die 26, 27 & 28] the comet was found stripped of any tail; at the beginning of February it did partly recover it again, but a little later it in turn entirely put off all its coma and the hairs adhering to it.

[Margin: Inſignis exporrectio atque deviatio Caudæ.] *A remarkable extension and deviation of the tail.* Moreover, as you should note well, although at first it directed its tail toward the west [occaſum], and then entirely toward the east [Ortum], yet at every time and place, throughout its whole duration, it constantly put it out toward the stars of Gemini, and at the same time also continually and quite precisely toward the point opposite the Sun, except for that real deviation which usually befalls comets. This deviation was northern at first, up to the perigee; but afterwards, up to the end, it reached 10° more or less [ad 10 plùs minùs grad.]: as can be seen in Book XI [Lib. XI].

[Margin: Quænam Zodiaci Signa motu ſuo retrogrado trajecerit.] *Which signs of the zodiac it crossed in its retrograde motion.* As regards the apparent motion: it should be known that this comet advanced against the order of the signs [contra Signorum ſeriem], that is, with a retrograde motion: namely from Corvus through Hydra, the Ship [Navem], Canis Major, Lepus, Eridanus, the Head of Cetus [Caput Ceti], as far as Aries; and indeed under a nearly great circle, namely around the middle of its route, where it was carried with a swifter motion. [Margin: Ab arcu circuli maximi ſenſibiliter deviavit.] *It deviated perceptibly from the arc of a great circle.* But just as around the end, up to the station, so also from the beginning, it by no means followed the course [ductum] of that circle, but turned aside from its orbit upward, toward Aquilo [Aquilonem], and the more so the nearer to the station it was observed; so that afterwards, as its course grew old, it turned its path, with a remarkable and very conspicuous curvature, toward the stars in the head of Aries. [Margin: Quanta fuerit à recto tramite deflexio.] *How great the deflection from the straight track was.* Indeed, at its crossing of the ecliptic near the ascending node [Nodum Aſcendentem] it had already deviated by more than two or three degrees, indeed by much more around the middle of the month of February; so that this comet by no means completed its whole course along the track of an absolutely great circle. [Margin: Magnitudo & variatio anguli inclinationis.] *The size and variation of the angle of inclination.* From this deviation it came about that the angle between the orbit and the ecliptic, and also that with the equator [tum Æquatoris], by no means always remained entirely equal to itself throughout

the whole time of the apparition. For the first [Is] was found to be 51° 20′ at the beginning, 49° 33′ in the middle, and at the end, namely on February 4 [4 ſc. Febr.], 51° 55′; the second [hic], however, 31° 23′ from the beginning, 30° 4′ in the middle, and 33° 21′ at the last, with a quite evident variation of both nodes: as we have clearly shown on page 111 of the *Mantissa* of the *Prodromus* [Mantiſſ. Prodr.].

[Margin: Cometæ ſitûs reſpectu Eclipticæ.] *The comet's position with respect to the ecliptic.* For the rest, as regards the motion in longitude and latitude: at the beginning of the apparition, namely on December 14, as we said, the comet stood in 7° 10′ of Libra, in a southern latitude of 21° 36′; but at the last, on February 12 at 9^{h} in the evening [hor. 9 veſp.], in 26° 53′ of Aries, in a northern latitude of 6° 40′. And so from the beginning it went below the ecliptic, in the southern region, until about January 16 [ad 16 ferè Januarii], where, having crossed the ecliptic, it took on a northern latitude, which it kept right up to the end; so that its greatest southern latitude was 49° 32′, but its northern no more than about 7°. [Margin: Motus apparens, ut ut inæqualis,regularisſimus tamen extitit.] *The apparent motion, though unequal, was nevertheless most regular.* And just as it had a motion in longitude that was quite unequal, though at every time supremely regular, so also it had a proper motion in its apparent orbit that was extremely varied. For from its rising the daily motion was scarcely 1°, but in the middle of its path, around December 29 and the perigee, 11° 51′; at the last, again, namely on February 4, when it was slowest, it was only 5′. [Margin: Quot Zodiaci Signa peragraverit–] *How many signs of the zodiac it traversed.*

Hence it is clear that this comet traversed in longitude 5 whole signs of the zodiac and about 11° [Unde liquidum eſt, Cometam hunc ſecundùm longitudinem 5 integra Signa Zodiaci atque 11° ferè]; but in its orbit, beginning from December 14 to February 12, 154° 36′ [154 grad. 36 min.]. Yet I readily grant that this comet appeared somewhat earlier: not only around the beginning of December, as was observed at Leiden [Lugduni Batavorum], but already around the end of November, on the testimony of Neubarthius [teſte Neubarthio]; so that the comet was visible for nearly three whole months. [Margin: Alibi citiùs quàm Gedani Cometa obſervatus eſt.] *The comet was observed elsewhere earlier than at Danzig.*

[Margin: Cometa ſe dem ſuam in ſummo habuit æthere.] *The comet had its seat in the highest aether.* As regards its seat and its distance from the Earth, this comet too, like all the preceding ones, stood entirely in the aether [planè in æthere extitit], as we have duly established from genuine parallaxes. Yet it did not keep one and the same distance throughout the whole time of its apparition, but was removed now more, now less from the Earth. [Margin: Quanta fuerit ejus parallaxis.] *How great its parallax was.* For its parallax was only 59″ at the beginning, but in the middle of its route, around its greatest apparent velocity and the perigee, about 4′, and at the last, again, only 16″. [Margin: Diſtantia genuina ejus à Terrâ.] *Its genuine distance from the Earth.* So at the beginning the comet was 3500 semidiameters of the Earth from the

Earth, in the middle 1000, and at the end, on February 4, 12,000 semidiameters of the Earth. [Margin: Quando Terræ fuerit propinquisſimus.] *When it was nearest the Earth.* It is therefore certain that toward the end of December the comet was nearest the Earth; nevertheless, even at that nearer remove it was found about twenty times [ferè vicies] more remote from the Earth than the Moon, but around the middle of January already more remote than the Sun, and around the beginning of February more remote than Mars itself.

In the highest aether, therefore, it completed its course; and indeed, likewise according to our opinion, in a nearly straight line, and with a true and most regular, supremely ordered motion [motuq́; vero regularisſimo ac ſummè ordinato], though partly unequal: namely somewhat more vigorous at the beginning, but somewhat slower at the last. [Margin: Motus verus in Trajectoriâ ferme rectâ, inæqualis quidem, ſed neutiquam irregularis extitit.] *The true motion in the nearly straight path was unequal indeed, but by no means irregular.* For at the beginning its daily motion in the path was 198 semidiameters of the Earth, but at the last, on February 4, 134 semidiameters of the Earth [S. T.]. [Margin: Trajectoriæ Situs.] *The position of the path.* The path of this comet, moreover, ran entirely outside the bounds of the annual orbit for its whole duration, and indeed above the intersections of all the lines of sight up to the beginning of February, but thereafter below the intersections [atverò deinceps infra ſections], so that the trace of the path [veſtigium Trajectorium], at its nearer distance, was 569 semidiameters of the Earth away from the great orb [orbe magno]. [Margin: Obliquitas.] *Obliquity.* And the angle of obliquity of the path, namely of the path and the trace, was about 17°; although this too was subject to evident variation, both from the beginning and at the end. [Margin: Incurvatio.] *Curving.* So we hold it certainly established from this that the path was by no means stretched out entirely in a straight line, but with a notable curving toward the Sun.

These are the things we wished to recount briefly about this celebrated and outstanding comet, which was without doubt seen over almost the whole world [per totum ferè Orbem]. [Margin: Specialiores Obſervationes alibi traduntur.] *More particular observations are given elsewhere.* Whoever wants more and more particular details, let him read without reluctance our particular observations, namely our *Prodromus Cometicus* [Prodromum ſcilicet noſtrum Cometicum], the *Mantissa* of the *Prodromus* [Mantisſam Prodr.] and Book XI of the *Cometographia* [Librumq́; XI Cometographiæ], as well as the observations of others, which were made in very many places of Europe by most distinguished men.

AD 1665. [Anno Chriſti 1665.]

[Margin: Prima Cometæ 1665 apparitio.] *The first appearance of the comet of 1665.* In AD 1665 [A.C. 1665], on April 6, New Style [St. N.], on Monday [die Lunæ], at 1^{h} 30^{m} [hora 1 30′] very early in the morning, a comet was noticed around Hellespontius [circa Helleſpontium], in the breast of Pegasus, namely

below those two stars, that is, at 14° 21′ of Pisces and northern latitude 26° 30′. Its body, as far as the naked eye could judge [quoad nudum adſpectum], was of a whitish and partly yellowish colour, like that of Jupiter, yet much brighter than the head of that preceding comet, although it appeared somewhat smaller.

With the aid of the tube, however, only a single round and very bright nucleus, of conspicuous size and shining like gold, was detected in the centre of the body; another, thinner and uniform matter received and surrounded it. [Margin: Color, figura atque magnitudo Capitis Cometici.] *The colour, shape and size of the head of the comet.* [Margin: Facies atque longitudo Caudæ.] *The appearance and length of the tail.* The tail, about 17° long [17 grad. ferè longa] and spread apart around its end, was cast toward the west [Occaſum versùs], between the mouth and the preceding foot of Pegasus. Just as it was somewhat narrower than the tail of that earlier comet, so it was also thinner, especially toward its point; yet at its very outlet it appeared quite dense and bright, of about the same density as the matter itself that stood around the head.

On April 7 [Die 7. April.] the head was still of about the same light and brightness, and with the aid of the tube the same single nucleus as before still appeared in the centre of the head. There was this difference, however: although it was almost unchanged in light and splendour, in size it seemed to me somewhat smaller; and the matter surrounding the head was in turn somewhat more packed together [aliquantò conſtipatior]. [Margin: Claritate ſuâ Stellas ferè ſuperabat.] *By its brightness it almost surpassed the stars.* On April 8 the head displayed an exceptional light, so that it was seen by the ordinary eye [populari adſpectu] even though most of the other stars had already almost faded out; the round nucleus in the middle appeared scarcely larger and brighter than hitherto. [Margin: Capitis magnitudo apparens.] *The apparent size of the head.* I determined the size of the head from the lunar spots [ex maculis Lunaribus]: the inner nucleus, with all the matter adhering to it, or the hair poured around it, was equal to the whole Island of Sicily, that is, at most 6′ [6 minutorum]; but the nucleus alone was no larger than the lunar Island of Corsica [Inſulâ Corſicâ Lunari], that is, 5/60 part [5/60 part.] of one lunar digit, or 12″ or 13″. Then I also made a comparison between the comet and Saturn; the comet's nucleus, however, did not yet quite reach the size of the round middle body of Saturn [corporis Saturni intermedii rotundi]. From this day to April 16 the head of the comet, with that round inner nucleus, remained in entirely the same state. [Margin: Caput fere lucidius ac aliquantò majus deprehenſum eſt.] *The head was found almost brighter and somewhat larger.* On this April 16, however, the comet surpassed in brightness almost all the other fixed stars, and indeed Saturn itself, namely by reason of its far more vivid colour, yellowing like gold; so that it struck the eye almost more than hitherto. Moreover, with the help of the telescope the inner nucleus was noticed to be very clear, and almost larger [ac major fermè]. Around the nucleus itself, however, almost no hair, or little thinner matter, was found on this day, and what remained appeared tapered to a point toward the Sun. [Margin: Proportio nuclei interioris Cometici ad

Jovem & Saturnum conſiderata.] *The proportion of the comet's inner nucleus to Jupiter and Saturn, considered.* The diameter of this nucleus, considered against Jupiter and Saturn, was found to be smaller indeed than that of Jupiter, yet equal to the diameter of the middle body of Saturn. From this it is inferred that in these days the comet had still grown, both in brightness and in bulk. For on April 8 its true diameter was only 168, but on this day, April 16, it was already 257 semidiameters of the Earth [Semid. T.]. Therefore the true diameter of this inner nucleus was seven times smaller than the diameter of the Earth, and in respect of solidity two hundred and ninety-six times smaller [ducenties nonagies ſexies minor fuit]. [Margin: Interior nucleus in ipſam Caudam quaſi umbram projiciebat.] *The inner nucleus cast a kind of shadow into the tail itself.* Furthermore, on this day I detected very clearly, as on the day before, that this nucleus, or this round body of which the head consisted, cast a conspicuous shadow from itself toward the tail, namely toward the parts turned away from the Sun. [Margin: In ipsâ Comâ quaſi fiſſura notata eſt.] *In the coma itself a kind of cleft was noticed.* For at the very outlet of the tail, at the nucleus itself, a kind of cleft [quaſi fiſſura] was seen. There the tail appeared much darker than on either side next to it, as if the nucleus (as indeed actually happened) denied the Sun's rays passage and prevented that part of the coma there from being illuminated.

This I contemplated clearly and distinctly, with the greatest admiration, both now and on the following days as well; at the beginning, however, I did not notice it at once, although without doubt the same phenomenon presented itself no less then too, since the same nucleus shone continually with the same appearance. [Margin: Caput Caudaq́; frequentes vibrabat radios.] *The head and tail darted frequent rays.* Moreover, the tail, together with the head itself, darted more frequent and more vivid rays; around its outlet it was still quite dense and fairly bright, yet it ended in very thin and very sparse rays scattered around its tip. [Margin: Materia in fronte Capitis evaneſcebat.] *The matter at the front of the head was fading away.* Here it should also be noted that the matter in front of the nucleus became not only more pointed from day to day, but also shorter and smaller, and indeed the more so the nearer the comet approached the Sun.

With this appearance it shone on the 17th, 18th and 19th as well. But on April 20, when the comet was observed by us for the last time, the thinner matter at the front of the head [in frontiſpicio capitis] had already been so contracted, attenuated and dispersed that very little of it remained any longer; on either side, however, it stood out fairly widely spread. [Margin: Cometa à parte anteriore omni capillitio penè orbatus viſus eſt.] *The comet appeared almost stripped of all its hair on its front side.* As far as the naked eye could judge, the head of the comet yielded in brightness to scarcely any fixed star. For in a position so close to the Sun, namely at a distance of 13°, Mercury would scarcely have been detected, let alone any fixed star. [Margin: Quousq́ue Cometa obſervatus ſit Dantiſci.] *How long the comet was observed at Danzig.* After this it was not seen by us any more, although, in my opinion, it could have been seen on April

21 and 22 if the weather had permitted. And so it was visible to us for only 14 days; at Aix-en-Provence [Aquis Sextiis], however, this phenomenon was detected as early as March 17, as the distinguished Boulliau [Cl. Bullialdus] has reported in writing.

[Margin: Caudam totâ duratione penè eandem exhibuit.] *It displayed the tail almost the same throughout its whole duration.* As for the tail, we must note that it presented almost the same appearance, both in splendour and in colour, for the whole time of its duration, except that up to about the 13th, or rather the 15th, of April it grew in length. [Margin: Quousque crines produxerit.] *How far it put out its hair.* Indeed it sometimes ran out to 20°, 22° or even 25° [ad 20, 22 imò 25 grad.], and that into a sharpened point. It was considerably widened, especially on April 15 and 16, but at the outlet it was, as hitherto, of exceptional density, pouring out and darting new rays, as it were. Moreover, on each side of the tail, around the outlet, it appeared much denser and rarer [multò denſior ac rarior], packed, as it were, with frequent rays; hence in the middle of the tail, at the head itself, a kind of cleft appeared, or some darker space, just as if that nucleus were casting a shadow. This phenomenon was also observed distinctly by us with the tube on the following days, almost up to the end. Thereafter, right up to the comet's setting [ad Occaſum usq; Cometæ], the coma became shorter, so that at the last, namely on April 20, it was no more than 3 or 4°. As for the direction of the tail, although it continually inclined toward different stars from day to day, it nevertheless always ran out as nearly as possible opposite the Sun, yet at some angle of southern deviation [Deviationis Auſtralis], and one varying from day to day, which grew at most to 14°. [Margin: Et hujus cometæ Cauda deviationi fuit obnoxia.] *The tail of this comet too was subject to deviation.*

[Margin: Curſus cometæ ratione Siderum.] *The course of the comet with respect to the stars.* As regards the apparent motion of this comet, it advanced through Pegasus, below the head of Andromeda, through the Northern Fish [Piſcem Boreum], toward Aries. And, in my opinion, it had its origin roughly above Sagittarius, and from there it passed through the breast of Antinous, below Aquila and Delphinus, to Pegasus. It therefore proceeded for its whole duration with direct motion, that is, following the sequence of the signs. [Margin: Fuit directus.] *It was direct.* For at the beginning, namely on April 6 [die ſc. 6 Apr.], the comet stood at 14° 21′ of Pisces and latitude 26° 30′, but at the last at 1° 18′ of Taurus, so that it remained continually in the northern region. In its path it did not entirely follow the course of a great circle.

[Margin: Variatio anguli inclinatinis atque Nodorum.] [recte: inclinationis] *The variation of the angle of inclination and of the nodes.* For the angle of the orbit, with the ecliptic as well as with the equator, and also the nodes themselves, evidently varied. At the beginning, on April 10, the angle of the orbit and the ecliptic [Angulus Orb. & Eclipt.] was 26° 38′, with the node standing at 7° 11′ of Gemini; but on April 20 the same angle was 36°. So this angle increased from day to day, while the angle of the orbit and the equator [angulo Orb. &

Æquat.] on the contrary decreased: it was found to be 27° 31′ at the beginning, with the node at 296° 30′, but at the end 26° 46′, with the descending node [Nodo Deſc.] standing at 87°. Yet right up to its last appearance it kept a most regular and highly proportioned motion, both with respect to the ecliptic and the equator and with respect to its own motion along its course [quà proprium in ſuo ductu], even though this motion too was unequal. For from its rising, on April 6, it was observed to be 4° 6′, but on April 20, 2° 23′.

[Margin: Parallaxis atque Diſtantia Cometæ à Terrâ.] *The parallax and distance of the comet from the Earth.* It follows that we should indicate at what distance the comet was removed from the Earth. This is known from the true parallax of the phenomenon, which was found by us to be 69″ on April 6, but 41″ on April 20, so that it decreased successively in due proportion; hence the interval of the comet from the Earth increased continually. Indeed, at the beginning, on April 6, that very interval was found to be 3000 semidiameters of the Earth [S.T.], but finally, on April 13, 5000 semidiameters of the Earth. It is therefore beyond doubt that the comet, even at the beginning of its rising, when it was nearest the Earth, travelled far above the Moon, indeed sixty times higher than the Moon [eâ ſexagies altiorem], namely around the perigee of Mercury [circa nimirùm Perigæum Mercurii]; but that afterwards it gradually made for still more remote regions toward the Sun, until on April 13 the distance of the comet nearly equalled the interval of the Sun from the Earth, 5127 according to our hypothesis. [Margin: Quando Cometa ad Solem usque pervenerit.] *When the comet reached as far as the Sun.* In the following days, since the comet withdrew continually from the Earth with a contrary motion [motu contrario], on April 20 it stood without doubt (as far as one may infer from the proportion of the parallax and the distances) far higher than the Sun itself, at about 7000 semidiameters of the Earth [ad 7000 circ. Semid. Terræ], namely in the middle of the orb of Mars. [Margin: Cometa ad Martem usque aſcendit.] *The comet rose as far as Mars.*

[Margin: Intra Orbem annuum Trajectoria, atque in altiſſimo æthere Cometa inceſſit.] *The path lay within the annual orbit, and the comet travelled in the highest aether.* It therefore travelled in the highest aether, within the annual orbit as regards its true motion, so that the trace of the path [veſtigium Trajectorium] intersects that orbit of the Earth [dictum orbem Telluris] at 20° 48′ of Scorpio, and the longitude of the path is at 22° 41′ of Taurus. Hence the path proceeds almost straight toward the Sun, at an angle of obliquity of the path with the plane of the ecliptic of only 2° 30′, that is, on a nearly parallel course with respect to the plane of the ecliptic, namely on the northern side, but with respect to the great orb [Orbis Magni] following the sequence of the signs [ſecundùm ſeriem Signorum]. [Margin: Trajectoria Cometæ non omninò fuit linea recta.] *The path of the comet was not entirely a straight line.* And yet this angle of obliquity too varied notably over time, from 7′ to about 15° [à 7 ſc. minutis ad 15 ferè gradus]; so that it is beyond all doubt that the true path too was in fact curved, partly toward the Sun and the plane of the ecliptic

[ex parte Solem planumq́; Eclipticæ versùs]. [Margin: Motus Cometæ verus in dies increvit.] *The true motion of the comet increased from day to day.* The daily motion of this comet, moreover, increased continually. For at the beginning it was only 184, but at the last 253 semidiameters of the Earth [Semid.T.].

These, then, are the things we wished, and were able, to record about all the comets. Nothing more remains than to add, by way of a corollary [Corollarii loco], a universal table setting out the chief and most memorable things noticed and recorded in comets from the founding of the world [ab Orbe condito] up to now, so that you may have, as it were at a single glance and in brief, the first appearance, place, motion and duration of any comet, the shape of its head and tail, its colour and its size. Yet, I admit, all these things have been carried out more fully and more accurately for one comet than for another. This, however, kind reader [Benigne Lector], is to be charged not to us but to our predecessors, whose task it would have been to observe those comets more exactly and to describe them more fully. For you see that, be it said without boasting [abſit jactantia dicto], we have amply performed our duty in the more recent comets, especially those observed by us ourselves, and have carefully and duly observed and handed down to memory everything worth noting. Farewell, and enjoy these [Vale, & his fruere].

A table showing all comets, and their principal phenomena, in order [Tabula, omnes Cometas, eorumq́; præcipua phænomena ordine exhibens.]

Years before the birth of Christ [Anni anteChriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
2292 / 2191 / 1920		one month / 65 days / 22 days		appeared in ♓ and / appeared in ♑ and / in ♈	traversed the 12 signs of the sky / traversed three signs	Jovial. / Martial.	
1820 / 1718		9 days		in ♌ / in ♐		Fiery, presenting the form of an imperfect circle rolled in upon itself, and its head that of a globe; terrible to look at.	

Years before the birth of Christ [Anni ante Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1495 / 1200 / 1100	In the month	of August. / 43 days		in ♒ / in ♊ / under ♈		In the form of a wheel. / Terrible to see.	
479							Ceratias: curved like a horn.
430		75 days	after sunset.			Fiery and Martial. Also: a great and unusual light, of the size of a large beam.	
411	January.			towards the north.			
371	In winter.		In the evening, after sunset.		It rose as far as the belt of Orion, and there vanished: therefore it was direct.	At first it had the form of a beam, and because of its excessive blaze it did not appear with scattered fire [ſparſis ignis]. At last it split into two stars.	The head, very close to the setting Sun, extended its brightness to a third part of the sky; and on the first day the tail was seen, not the head.
354				first in ♌			Changed from the likeness of a mane into a spear.
339		A few days / 19 days	never *veſp. or.*	Around the equinoctial, in ♐			
220 / 196 / 194	first / second	22 days / a few days / 19 days / 80 days		in ♈ / in ♒ / in ♋		Of astonishing size.	

Years before the birth of Christ [Anni ante Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
183 / 174 / 172		80 days / 32 nights / 55 weeks		in ♓ / in ♈		Surpassing the brilliance of the Sun with its own brightness.	Occupying almost a quarter of the sky.
166 / 154	September 4	9 days		in ♉		Called Hircus.	
144		22 days				No smaller than the Sun. At first it was a fiery and ruddy orb, giving off a clear light, as much as would overcome the night; then it gradually diminished. Seneca.	
134		83 nights		in ♊		At first moderate, then it raised itself and spread out, and came as far as the equinoctial circle, so that, stretched out to an immense extent, it equalled that region of the sky which bears the name of the Milky Way. Seneca.	
122		80 days				It shone so brightly that the whole sky seemed to be on fire. For by its size it had occupied a quarter of the sky, and by its brightness it had surpassed the brilliance of the Sun; and in rising and setting it took up a space of four hours. Justinus [Juſtin.].	
111		15 days	in the evening.	in ♋			together with a splendid light.
65		94 days		in ♍		A terrifying and huge star.	

Years before the birth of Christ [Anni ante Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
60		9 days		It was seen when the Sun was totally eclipsed, whereas [oum] [recte: cum] it had previously been hidden by the Sun's rays. Seneca.			
47							
41				in ♏, towards the north.		Of dreadful size.	Xiphias: a sword with a tapering point.
29		95 days		in ♎			
27 / 23		7 days / some days	around the eleventh hour of the day.	in the north. / in Taurus.		A bright star, conspicuous to all.	

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Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
I / 10 / 14		3 nights / 32 nights / 20 days		in ♌ Rockenbach [Rockenb.] / in ♈ Rockenbach / in ♈ Rockenbach			A burning torch.
40				in ♊			

[697]The table is ruled in eight columns and twenty-two rows; every column has twenty-two ruled cells, and a ruled row may hold more than one year. Within a cell, a slash separates the printed lines where they belong to different years of the row; the line placement is as follows. In the first row, 2292 has one month, appeared in Pisces and traversed the 12 signs, Jovial; 2191 has 65 days, appeared in Capricorn and traversed three signs; 1920 has 22 days, in Aries, Martial. In the second row, 9 days and Leo stand beside 1820, Sagittarius beside 1718. In the third, Capricorn and the wheel stand beside 1495; the month of August, Gemini and terrible to see beside 1200; 43 days and under Aries beside 1100. In the row for 220, 196 and 194, the year 196 carries two comets, marked first and second on two lines: the first with a few days and Capricorn, the second, on a line that prints no year, with 19 days and Cancer; Of astonishing size stands beside the second comet of 196 and the year 194; 22 days and Aries belong to 220, 80 days to 194. In the row for 183, 174 and 172: 80 days and Pisces with 183, 32 nights and Aries with 174, 55 weeks with 172; both descriptions stand beside 183 and 174. In the row for 166 and 154: September 4 and Hircus beside 166, 9 days and Taurus beside 154. In the last row, 7 days, the eleventh hour, the north and the bright star stand beside 27; some days and Taurus nearer 23. Several cells run on into the next column line by line: in the first row the words of the place column continue in the motion column, and the word percurrit is divided by the column rule; in the third row In the month runs on into of August; the quotations from Seneca (rows 134 and 144) and from Justinus (row 122) run line by line from the head column into the tail column, and are given here whole in the head column; in the row for 60 the closing Seneca is divided between the place column and the motion column, and is given whole in the place column. The table is set in italic, the years and day-counts in roman figures.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
54		4 months		in ♋ Rockenbach	Rising from the north towards the zenith, it made for the east. Seneca.	Always dimmer.	
60		6 months		In the north.	Moving from the north towards the west, it turned to the south, and there withdrew from sight. Also: it traversed half the sky.	Always dimmer.	
64 / 66				in ♊		A cometary star.	
71		for a year.		in ♍			Sword-shaped. That is, the one of Jerusalem.
76							Acontias, in the form of a javelin
79		180 days		in the sign ♏. Rockenbach [Rock.]			
128 / 145		39 nights / 6 nights		in ♒ and ♌ / in ♒			
188							

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
204		for many days.					
218		18 days		in the sign ♓	It advanced from the west into the east.		
308 / 323				in ♍			
337		6 months		in ♈		Of immense and terrible size. Rockenbach. / Of unusual size. Eutropius [Eutrop.].	
367 / 370		several days / 11 weeks	by day	in ♈			
380	At the beginning of May.	4 months		in ♎		Of round shape, larger than the planet Venus, and it lit up the whole horizon.	
384 / 389 / 390		20 days / 30 days	rising at cock-crow.	in ♊ towards the north.		Like the one of Jerusalem. Burning like the Morning Star. Like a hanging and burning dove or column.	
392		40 days	around midnight.	Near the Morning Star, around the zodiac.	From the place of Venus it gradually climbed to Ursa Major [Vrſam majorem], and vanished in the middle of it.	Huge and bright like Venus; very many other stars gathered to it little by little and made up the figure of a sword, whose hilt the first bright star supplied.	
396							
400 / 402						Resembling a sword, and exceedingly splendid; and so large that it reached from almost the top of the sky down to the earth itself.	

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
409 / or / 413	Around the total eclipse of the Sun.	4 months and more		in ♍	It advanced from the equinoctial east through the tail of Ursa Major into the west.	A blaze presenting the appearance of a cone or turning-post; nor did it look like a star, but it seemed to stand by itself like the flame of some great lamp. Its vertex sometimes went off into a great and sharp length, so that it exceeded the proportion of a cone; at other times, however, it was drawn back to its [?] measure.	
418	August 14	until September.		in ♎			
423						Horrible.	
442		for very many days.	during an eclipse of the Moon.				
448		for many days.		in the east in ♌			

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Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
454 / or / 457						A star of wondrous size appeared, to whose ray clung a fiery sword like a dragon. From its mouth two rays proceeded, of which one extended beyond Gaul, while the other, stretching again towards Ireland, ended in seven smaller rays.	
459 / 488						Surrounded by a dark cloud, shining with its own ray.	

[698] The table continues with its column heads set again, but the first column is now headed Years after the birth of Christ, where the preceding page has Years before the birth of Christ; the years here, 1 to 448, are years after Christ. The page carries eight columns and twenty-five ruled rows; every column has twenty-five ruled cells, and a ruled row may hold more than one year. Within a cell a slash separates printed lines that belong to different years of the row. In the first row, 3 nights and Leo stand beside 1, 32 nights and the first Aries beside 10, 20 days and the second Aries beside 14; A burning torch stands level with 1. In the row for 64 and 66, A cometary star stands beside 64 and Gemini beside 66. In the row for 128 and 145, 39 nights with Aquarius and Capricorn belong to 128, 6 nights with Aquarius to 145. In the row for 367 and 370, by day and several days stand level with 367, 11 weeks with 370. In the row for 384, 389 and 390, nothing in the duration column stands beside 384; 20 days stands beside 389 and 30 days beside 390; rising at cockcrow and Gemini, towards the north, stand between 384 and 389, nearer 389; the three descriptions of the head are not aligned with the years. In the row for 409 and 413 the two years are joined by the word or, and 4 months and Virgo stand level with 409. Several entries run on line by line from the head column into the tail column (rows 337, 392, 400/402 and 409/413), and the words terribilis, magnitudinis, Veneris, aggregatae, praestitit, constituerunt, speciem, subsistere, acutam, pertingeret and mensuram are divided by the column rule; these entries are given here whole in the head column. The table is set in italic, the years and day-counts in roman figures.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ appariſtion.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
504		several nights.					A very long tail, together with the likeness of a dragon, crowned and burning.
519		26 days.		In the east.			Like a beard, the comet sent out rays towards the west.
539	December.			in ♐			
541	At Easter.					Remarkable.	
556					From the north into the west.		In the form of a lance.
570							
589		For a month.				Surrounded by a dark cloud, shining with a single ray.	
594 / 597	January.	For a month.	At morning and evening time.			Terrible to look at.	
599							
601	September to November.	For very many days.				A very great comet.	With the gleam of a sword, without any rays.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ appariſtion.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
604 / 604	April and May. / November and December.					Very bright.	
613		For a month.				Of the nature of ♀.	
633		30 days.		Towards the south.			In the form of a sword.
676	August.	3 months.	From cock-crow to sunrise.	In the east.			It displayed a lofty flame, like a column.
684	Between the Nativity of Christ and the Theophany, that is, the feast of the Three Kings.	3 months.	Day and night.	Near the Pleiades (in the east).	On February 14 that star went forth in the evening from the south to the north.	With a dim light, like the Moon showing through a thin little cloud.	
729	January.	14 days.	In the morning before sunrise, and in the evening after sunset.				A fiery [?] torch faced the north [Aquilonem].
745	Towards the end of the year.						

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
761		10 days / 21		Seen for 10 days in the eastern quarter, and afterwards for 21 days in the western quarter.			
763				In the east.		Remarkable and terrible.	In the figure of a beam.
800							
814	November.					Singular and terrible, wonderful in light and appearance, like a double moon, clearly coming together and parting; and, among other things, showing the likeness of a man without a head.	

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Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Temp⁹ durationis vel· diſparitionis. ·]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
830				in ♈			
837	At Easter.	25 days		It appeared in ♍, and indeed in that part where its feet touch the tail of the Serpent and Corvus.	It traversed ♎, ♋ ♊, and at last vanished in the head of ♉, from east into west, retrograde.		
838	In autumn.		In the morning, before sunrise.	in ♎		Horrible to human sight.	
839	In spring.	some days.	In the evening, after the setting of ☉.	in ♈			
842				in ♒			
844				Above Venus.			
868							

699 The table continues with its column heads set again. The first column is again headed Years after the birth of Christ, and the years here run from 454 to 814. One heading changes: the third column, headed on the two preceding pages Duration, or time of disappearance, is here headed Duration, or time of appearance, and its words are set in full. The page carries eight columns and twenty-three ruled rows; every column has twenty-three ruled cells, and a ruled row may hold more than one year. Within a cell a slash separates printed lines that belong to different years of the row, or, in the duration column of the row for 761, two figures printed one under the other with no word between them. In the row for 454 or 457 the two years are joined by the word or. In the row for 459 and 488 the description of the head begins level with 459. In the row for 594 and 597, January, For a month, At morning and Terrible to look at stand level with 594. In the row for the two years printed 604, April and May stand beside the first 604 and November and December beside the second; Very bright stands level with the first. Two entries run on line by line from the head column into the tail column (rows 454 or 457 and 589), and the words gladius, similis, Galliam, circumdatus and the word after alter are divided by the column rule; these entries are given here whole in the head column. The table is set in italic, the years and day-counts in roman figures.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempº durationis vel· diſparitionis. ·]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
874	At the beginning of April.	The whole month.	by night and by day.	Preceding the Moon [præeedens].			Stretched out lengthwise with fiery rays.
875	June 6	Some nights.	by night and by day.			Twinkling more than is fitting and redder than usual, and then throwing out long hair.	
882	January 18						A long tail.
902		40 days					Its tail thrown out towards the east.
904	In May.						
908						Redder than usual.	
930				in ♋			
942	November 17	14 nights					
945						Of wondrous size and length, spreading fiery rays.	
962						Of unusual size.	
975	August.	8 months				Of a fiery colour.	
983							
1000 / or / 999	At the beginning / December 12		At the 9th hour, in the evening.			Of dreadful size.	

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Temp⁹ durationis vel· diſparitionis. ·]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1005 / 1009	For a long time / towards the end of May.			In the southern quarter / Around the south.		horrible. / Terrible.	Scattering flames this way and that.
1017		4 months		in Leo		More wonderful than usual.	In the manner of a very great beam.
1027							
1031 / 1038							
1042	October 6	throughout that whole month.	In the morning.		Advancing from east into the west, retrograde.		Having long and flaming hair.
1058							
1066	At Easter.	40 days		Following the Sun, in the west [Occid.].		At first it was almost equal to the Moon; then, as the tail grew, its size decreased.	
1067 / or 68							

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Years after the birth of Christ [Añi poſt Nativitatem. Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Temp[9] durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma; Situs.]
1071		25 days	In the morning.	In the east.			long and flaming hair
1096 / or / 1097	On the first of October.	A week		In the west and VS		Not very bright.	Sending out from itself a single faint ray, like the Moon.
1098 / or / 1099	About the nones of October.	15 days		In the southern quarter.			Its splendour stretched out obliquely, like a sword. / Its larger hair stretched out towards the east, its smaller towards the south; Rockenbach.

[700] The table continues with its column heads set again. The first column is again headed Years after the birth of Christ, and the years here run from 830 to 1067 or 1068. One heading changes back: the third column, headed on the preceding page Duration, or time of appearance, is here headed again Duration, or time of disappearance, as on the two pages before that. The page carries eight columns and twenty-eight ruled rows; every column has twenty-eight ruled cells, and a ruled row may hold more than one year. Within a cell a slash separates printed lines that stand level with different years of the row. In the row for 1000 or 999, At the beginning stands level with 1000 and December 12 nearer 999; the page does not show whether the two lines are one entry. In the row for 1005 and 1009, For a long time, In the southern quarter and horrible stand level with 1005, and towards the end of May, Around the south and Terrible nearer 1009. In the rows for 1000 or 999 and for 1067 or 68 the years are joined by the word or. Three entries run on line by line from the head column into the tail column (rows 875, 945 and 1066), and the words projiciens, Lunae and crescente are divided by the column rule; these entries are given here whole in the head column. The table is set in italic, the years and day-counts in roman figures.

Years after the birth of Christ [Añi poſt Nativitatem. Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Temp^{9} durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma; Situs.]
1101			Immediately after sunset.	In the west.		Of wondrous size.	
1102 / or / 1103	February 22			In the east.	Changing its place by leaps, at long intervals.		With flames glowing red far and wide.
1104							
1106	In the first week of Lent / and / a little later	Up to the Lord's Passion, for 25 days	Around evening. / In the morning.	Towards the south and the west. / In the east.		Large and horrible.	The splendour that went out from it was very bright, and like a huge beam. Long and flaming hair
1109		For some days.					
1110	July 6	6 months.			With retrograde motion.		Rays directed towards the south.
1113	In May.					A huge comet.	
1132 / or / 1133 / 1141	On the ides of October.					of dreadful size	
1145	In May.						
1146		For a month		In the west.			Lighting up the neighbouring air all around with rays poured about it.
1165 / Two together.			Before sunrise.	Two: one of them towards the south, the other towards the north [Aquilonem].		Two together, or one with two very long rays.	

Years after the birth of Christ [Añi poſt Nativitatem. Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Temp⁹ durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma; Situs.]
1168	December 24	After a long interval they ceased to appear.		In the west.		Two stars of fiery colour, one large, the other small; they were as if joined, and afterwards were separated.	
1200				in 15° ♏	Against the order of the signs.	Its solid part appeared three times larger than Venus, and of round shape; and its light was as great as if a quarter of the Moon were shining.	
1211	In May.	18 days		Near the Arctic pole.			Directing its tail towards the east in the evening, towards the west in the morning.
1214 / Two. / 1217	March. / In autumn		One in the morning, the other in the evening, after sunset.	One before sunrise, / the other after sunset. / In the southern part, gradually declining towards the west, opposite the Crown of Ariadne.		Terrible to human sight.	It was seen to rise like a beam right up to the middle of the sky.
1223	Around the feast of St Peter in Chains.					A burning and haired star, horrible to see.	

Years after the birth of Christ [Añi poſt Nativitatem. Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Temp⁹ durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma; Situs.]
1240	February.	6 months	In the evening.	Towards the west / and / near the Arctic pole		A dark star.	Its tail stretched out towards the east. / Its tail stretched out towards Eurus.

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Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Temp⁹ durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs,]
1241	January.	30 days				Terrible to see.	

[701]The table continues with its column heads set again, the third column again headed Duration, or time of disappearance, as on the preceding page. The years here run from 1071 to 1240. The page carries eight columns and twenty ruled rows; every column has twenty ruled cells, and a ruled row may hold more than one year. In the rows for 1096 or 1097, 1098 or 1099, 1102 or 1103 and 1132 or 1133 the years are joined by the word or; in the row for 1165 the year column adds Two together, and in the row for 1214 and 1217 it prints Two between the years. Within a cell a slash separates printed lines that stand level with different years of the row, or separate entries set one below another. In the row for 1098 or 1099, the entry on the sword-like splendour stands level with 1098 and the entry on the larger and smaller hair, credited to Rockenbach, level with 1099. In the row for 1214 and 1217, March stands level with 1214 and In autumn level with 1217; the place of the comet runs on line by line from the fifth column into the sixth, the word Ariadnes divided by the column rule, and the entry is given here whole in the fifth column. The tail entries of the rows for 1071 and 1106 have no closing point, and the first opens without a capital. The table is set in italic, the years and day-counts in roman figures.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ appariti-on.]	Duration, or time of disappearance [Temp° durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs,]
1245	Around the Ascension of the Lord.			In ♍.		Large, a star like ♀, reddish like ♂, without a tail; perhaps it was ♂ itself.	
1254 / 1255		For some months.				Of immense size.	
1264	In July.	3 months, / to October / 7.	It rose in the morning.	In ♉, after ♀, the Morning Star.	Moving from east to west, it at last went ahead of the Morning Star.	Of remarkable size.	The tail appeared far and wide before the comet rose; and once the comet had risen, it sent out rays from the east as far as the middle of the sky, towards the west. The tail, however, decreased day by day.
1268		For several days.	Around noon.			Of astonishing size.	
1284 / About.						Of remarkable size.	It directed its hair towards the west.
1298	In summer.						
1300						Horrible.	

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ appariti-on.]	Duration, or time of disappearance [Temp⁹ durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs,]
1301	On the Kalends of December, or rather around the feast of Michael, according to Edda.	15 nights	It appeared after sunset and set before midnight.	In ♒ and ♓.	From the east towards the north [Aquilonem].		Its hair directed towards the east.
1304		3 months		Towards the north			
1305	In the week of Christ's Passion.					Of dreadful size.	
1307							
1312		14 days			From the north towards the south.	Of dreadful size.	
1313					From the north towards the south, in line with the motion of ♂.		
1314	In autumn, / in the month of October.	3 months / 6 weeks, another gives.		Towards the north [Aquilonem] at the end of ♍.		Of horrible appearance	Directing its flame towards the north [Aquilonem].
1315	December.	Up to February		in ♋		Terrible.	

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ appariti-on.]	Duration, or time of disappearance [Temp⁹ durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs,]
1337 / Two.	April. / May. / June. / July.	The first, 4 months; / the other, three / months: June, July, August.		The first in ♉.			
1338	In June.		In the evening.	Around the feet of Pegasus.	It climbed towards the north about 3° a day, through the Bear, that is, Ursa Minor, the right foot of Hercules and the left hand of Ophiuchus,	Bearded.	Like a sword, stretching out its hair towards the east.
1239 / or 1340 / or 1341	In March.			Near Spica ♍ it appeared, and, advancing one degree each day, it disappeared when it had reached ♌.			In the shape of a sword.
1347	August.	2 months		In ♉ towards the north.			

Years after the birth of Christ [Añi poſt Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1351 / or 1352	December. / September.			Directly under the north.			
1353							

[702] The table continues with its column heads set again, in the same words as on the preceding page; the punctuation of the heads differs, and the page is followed: the first column has no point after Nativitatem, the fourth has a space before the comma after diei, the fifth has no space after the comma after mundi, the seventh has no space before the comma after Magnitudo, and the eighth has a comma after Forma (the preceding page has a semicolon) and a comma after Situs. The years here run from 1241 to 1347. The page carries eight columns and twenty ruled rows; every column has twenty ruled cells, and a ruled row may hold more than one year. In the row for 1254 and 1255 the two years share one cell; in the row for 1284 the year column adds About, and in the row for 1337 it adds Two. The year printed first in the row that follows 1338 reads 1239, joined by or to 1340 and 1341; it is given as printed. In that row the place of the comet runs on line by line from the fifth column into the sixth, the words apparuit and progrediens divided by the column rule, and the entry is given here whole in the fifth column. In the row for 1338 the entry on the motion ends with a comma, the last mark in the cell. In the row for 1301, Edda is given as printed. In the row for 1337, the four months stand one under the other beside the year. The table is set in italic, the years and counts in roman figures.

Years after the birth of Christ [Añi poſt Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1362	March / 11.	Several days. / 5 weeks.	All night, or continuously visible.	At the end of Aquarius (no doubt with a considerable northern latitude, so that it stood near the upper wing of Cygnus and was continuously visible.)			Its tail directed towards the east. / In the evening, evidently.
1375 / 1380		3 months.		in ♒.		A haired star.	
1382	In August	14 days.					

Years after the birth of Christ [Añi poſt Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1394			In the evening	Passing in the west towards the north.		A Spit, its head hanging downward and its hair raised upward.	
1399							Three large, fiery tails of comets were seen.
1400	In Lent.			Towards the north, in the eastern angle. / Pontanus and Mizauld.	It was carried towards the east with no small speed.	A most fiercely burning comet.	A long tail.

Years after the birth of Christ [Añi poſt Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1401	At the end of / February.			In the western quarter.		A great comet, dreadful, bright and clear.	Its tail spread out like a peacock's; Rockenbach. Unfolding its hair erect in the appearance of flaming fire, over 4 cubits long, it shot its rays from west to east just like a spear; and when the Sun had sunk below the horizon, pouring out its own rays, it lit up all the bounds of the world, and allowed neither the other stars to put forth their light nor the air to be darkened by the shadow of night, because its light outshone the splendour of the others, and it stretched its flame up to the zenith of the sky for as long as it stood above the horizon.
1402 / 1403	Before Shrovetide.	For many days.	After sunset.	Towards Corus. / Between the east and the north.			A lurid and funereal tail stretched upward like a lance, three feet thick, sometimes more, sometimes less. / Its tail stretched out towards the north.
1407 / or 1408							
1432	At the beginning of February.					Of slight size.	Its tail stretched out towards the north.

Years after the birth of Christ [Añi poſt Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1433		3 months	From evening to dawn.			Glowing red, bright and very large.	
1435	In autumn.						
1439 / 1444	At the time of the solstice.			in ♌.			
1450	In summer.		Immediately after the setting of ☉.		Passing under the full disc of the Moon, it caused an eclipse. Its motion was from west to east.		In the likeness of a rhomphaea.

Years after the birth of Christ [Añi poſt Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1456 / Two.	In June.	For a month.		in ♋ and ♌, / one towards the west, / the other towards the east.			Its tail longer than 60°.

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Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1457	In June.	For a month.		in 20° ♓		Black.	
1460						A very bright and huge comet.	
1463						Very bright.	

[703] The table continues with its column heads set again, in the same words as on the two preceding pages, but set differently: the first column prints Christi before Nativitatem, the third writes Tempus in full and breaks its lines differently, and the eighth adds a comma after Magnitudo and has a comma after Forma and a full point after Situs; the page is followed. The years here run from 1351 to 1456. The page carries eight columns and seventeen ruled rows; every column has seventeen ruled cells, and a ruled row may hold more than one year. In the rows for 1351 or 1352 and 1407 or 1408 the years are joined by the word or; in the rows for 1375 and 1380, 1402 and 1403, and 1439 and 1444 the two years share one cell; in the row for 1456 the year column adds Two. In the row for 1351 or 1352, December stands level with 1351 and September level with 1352. In the row for 1375 and 1380, the place in ♒ and the description of the head stand level with 1375 and the duration of 3 months level with 1380. In the row for 1402 and 1403, the first tail entry stands level with 1402 and the second level with 1403; the place towards Corus stands level with 1402 and the place between east and north level with 1403. In the row for 1439 and 1444, the solstice and the place in ♌ stand level with 1444. The day of the row for 1362 is printed as two sorts of the form used for the figure 1 in the years, followed by a point, and is given as II. In the row for 1394 two entries run on line by line across a column rule: the place of the comet from the fifth column into the sixth (the word transiens divided by the rule), and the description of the head from the seventh column into the eighth (the word deorsum divided by the rule); each is given here whole in the column where it starts. In the row for 1400 the place of the comet is credited to Pontanus and Mizauld, and in the row for 1401 the first tail entry to Rockenbach. The table is set in italic, the years and counts in roman figures.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1467	After Michaelmas; very rarely seen, because of the rainy weather.			In the sign ♓ or ♋ / doubtful. / perhaps ♍ should be put in place of ♋.			It sent out its hair towards the east, with ☉ in the middle of ♎.
1472 / Regiomontanus.	At the end of December. / At the beginning of the year.	80 days	At first in the morning, at the last in the evening, in the middle all night long.	From the stars of Virgo, through Boötes, Draco, Ursa Minor, the feet of Cepheus, the breast of Cassiopeia, the belly of Andromeda, the Northern Fish, it came to Cetus, and there ceased to be seen at its heliacal setting; always retrograde. Slow at the beginning and the end, very swift in the middle, so that in one day it covered 40° of its great circle.		The head at first thin, soon of wondrous size, then smaller again; sometimes white, sometimes flaming.	The tail short at the beginning and the end, in the middle more than 50° long; like a pole or a javelin, and directed towards different quarters of the world at different times.
1477						Blackish, with a bluish pallor.	

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1491	Around the feast of the Epiphanies.		In the evening.	Under the third face of ♓, at the beginning of ♈, with southern latitude.		With a head not large.	With a longer tail, or a thin one of little light, stretched out behind it towards the east.
1500 / another.	April. / January.	4 months. / 10 days.	Seen day and night.	In the north, under the sign ♑. Also ♐ and ♒.			
1505	Around the feast of Michael	Up to the Bacchanalia of the following year.	From the 4th hour to the 8th of the morning, or from the 4th hour before sunrise to the 8th after sunrise.		From the south towards the west.	A large star, shining as beautifully, and almost as brightly, as the Moon.	
1506	April 12	25 days			Directing its motion from west to east.		

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1506	August.	On August 15 it ceased to be seen in Poland.		Near the pole, above Ursa Major, it appeared at first; on the following day within the stars of the Wain, afterwards below them, until at last it reached the horizon altogether and so withdrew from sight; it passed through ♋, ♌ and ♍.		Of a hideous and bright appearance.	A splendid and dense tail, from which it was called the Peacock's Tail.
1511 / or 1512	May 30 / March and / April.	To July 3.		in ♌		Of blood-red colour.	
1513	December.	From the end of December / 19, up to February	All night.		It ran out from the end of ♋ to the end of ♍.	Of various colours.	And with an oblong tail.
1516		For some days.				Of lunar nature.	
1521	April.			At the end of ♋.		Bright, and like the Moon at dichotomy.	Having short hair.
1522				Towards the setting of the Sun.		Of Saturnine nature.	

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparition.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi,& Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1523	In November.						
1526	From August 23.	To September 23.					Like a fiery sword.
1528	January 18.			in ♓ in ☌ to ♄.			
1529 / Four together.				Opposite one another.		I doubt whether they were genuine comets.	Turning their tails towards the four quarters of the world.

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[704] The table continues with its column heads set again, in the words of the preceding pages but with two changes, and the page is followed: the third column reads time of appearance (apparitionis) where pp. 1033–1035 read time of disappearance (disparitionis), and the first column again sets Christi after Nativitatem, as on pp. 1033–1034; the punctuation of the heads differs again from page to page. The years here run from 1457 to 1529. The page carries eight columns and twenty ruled rows; every column has twenty ruled cells, and a ruled row may hold more than one year. The year 1506 heads two successive rows, each a comet of its own, kept as printed. In the row for 1472 the year column adds the name Regiomontanus, divided over two lines; in the row for 1500 it adds another, and the entries standing level with that word (January, 10 days, seen day and night) are another account of the same comet; in the row for 1511 or 1512, May 30 stands level with 1511 and March and April level with 1512; in the row for 1529 it adds Four together. In the rows for 1472 and the second 1506 the place of the comet runs on line by line from the fifth column into the sixth, words divided by the column rule, and each entry is given here whole in the fifth column. In the row for 1513 the figure 19 opens the second line of the duration, after the end of December and before up to February, and is given in that position. The table is set in italic, the years and counts in roman figures.

Years after the birth of Christ [?] [[?]ñi poſt Nativi[?] [?]hriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1530	In June.						
1531 / Apian.	August 6.	To September 3.	At first in the morning before sunrise; at the last, seen in the evening after sunset.	Advancing from the beginning of ♌ to the beginning of ♎, its northern latitude also decreasing daily.		Reddish, or rather yellow.	
1532 / Apian.	September 25.	To November 20.	In the morning, before the rising of the ☉.	Moving from the beginning of ♍ to the beginning of ♏; its latitude southern at the beginning, northern at the end.		A star three times larger than Jupiter, of a certain dark pallor.	Stretching out a very long and radiant tail between the south and the west.

Years after the birth of Christ [?] [[?]ñi poſt Nativi[?] [?]hriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1533 / Apian.	At the beginning of June.			At first it was in ♊ near Perseus; from there it went back into ♉, with its northern latitude increasing day by day.		The comet's head a little larger than Jupiter.	The tail equalled the length of a soldier's spear. Fracastoro. It had the likeness of a rhomphaea. / It covered 15° on June 21.
1538 / Apian.	January.	For three weeks.	In the evening.	In the west, at the beginning of ♓, with a northern latitude of 17°.		Of fiery colour; but others hold that it was dark and pale.	The tail 30° long, stretched out towards the east.
1539 / 1541	May 6. / August 21	To May 17	In the evening.	In ♌, its latitude northern at first, southern at the last.	Motion in the order of the signs, direct, but from the north into the south.	Head small and dark. / Showing the form of a dragon.	A short tail. / And having a fiery tail.
1542		40 days.				Terrible.	
1545		For some days.		In the west.		Of blood-red colour.	
1554		For some days.				Of fiery colour.	The tail directed towards the west.

Years after the birth of Christ [?] [[?]ñi poſt Nativi[?]tatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1556	March 5			From the left wing of Virgo it climbed through Boötes to the northern pole of the ecliptic; from there it came through Andromeda to the Northern Fish, where it was extinguished. In the middle very swift: it covered 15° a day. At first it was retrograde; at the last it became direct.		Both its rays and its colour were changed. / A shining globe of flame, equal to half the Moon.	The tail sparse and thin, and pale rather than red; narrower near the head than at the end; stretched out towards the west, in the direction opposite the Sun.
1557	In the month of October.			In the western quarter. / in ♐			In the form of a dagger, the globe of its fire sending out a radiance that ended in a single point; of pale colour, and with sparse and meagre light.

Years after the birth of Christ [?] [[?]ñi poſt Nativi[?]tatem [?]hriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1558 / 1559	August. / At the end of May.	To the Nones of September. / To June 2.	Towards evening.	Under Coma Berenices. / Above Leo. / In the east.	Inclining towards the east.	Of pale colour.	
1560 / 1664	December 28.	28 days.					
1569	Around the beginning of November.	Up to the end.	In the evening.	In 5° of Capricorn, near the bright star of Sagittarius, in the west; but Riccioli has it that it shone in Serpentarius and in the signs of Sagittarius and Capricorn.	Moreover it advanced out of Cancer, and towards the end, leaving its straight course, it turned aside towards 4° of Virgo, where it became stationary.	A comet of bright colour, and radiant with burning flames, with its tail turned towards the east.	

Years after the birth of Christ [?] [[?]ñi poſt Nativi[?] [?]hriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1577	November 9.	3 months.	In the evening at the 5th hour.	Around the beginning of ♐. As to its true place, it stood in the highest aether: for its parallax was 19′ 12″ at the beginning and 2′ at the last, so that its distance from the Earth was found to be 173 semidiameters of the Earth at the beginning, but 1733 at the last.	From the beginning of Capricorn, through the meeting of the equator and the meridian line passing through the pole of the zodiac, it advanced between Equuleus and Delphinus as far as the breast of Pegasus, its motion continually decreasing. It thus passed through Capricorn and Aquarius to the middle of the sign of Pisces, yet in such a way that it bounded the places of the beginning and the end of its motion within the two tropics, and in this way completed a quadrant of the sphere.	Of horrible appearance; the colour of its body bright, just like the purest silver, slightly reddish; of the size of Venus or Jupiter, or, as Tycho has it, 7′, so that its true diameter [Dimeter] [recte: Diameter] was 368 miles.	The tail of an almost blood-red colour, from vapours mixed through it; thrown out far into the part opposite the Sun, yet in such a way that, curved, it gradually bent round and rose with its rays tending into an arc, turning its convex side, that is, towards the zenith, but its concave side towards the horizon. Its length was sometimes seen as 22° and 30°; its breadth about 5°.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Temp. duratio-nis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1578	May 16		In the evening, at the 9th hour.	Towards the east and the south.			Having a long tail, and stretching it out towards the north.

[705] The table continues with its column heads set again in the words of p. 1036, with the second term of the third column again apparitionis (time of appearance); the punctuation of the heads differs again from page to page. The first letter of three lines of the first head stands in the fold of the binding and cannot be seen; the head is otherwise the one set on the preceding pages. The years here run from 1530 to 1577. The page carries eight columns and fifteen ruled rows; every column has fifteen ruled cells, and a ruled row may hold more than one year. In the rows for 1531, 1532, 1533 and 1538 the year column adds the name Apian (printed Appian.), crediting the entry to him. The rows for 1539 and 1541, 1558 and 1559, and 1560 with the year printed 1664 each share one ruled row, the entries standing level with each year belonging to that year: in the row for 1539 and 1541, May 6, To May 17, In the evening, the place and motion, the small dark head and the short tail stand level with 1539, and August 21, the dragon's form and the fiery tail level with 1541; in the row for 1558 and 1559, August, To the Nones of September, Towards evening, Under Coma Berenices, Inclining towards the east and Of pale colour stand level with 1558, Above Leo between the two, and the end of May, To June 2 and In the east level with 1559. The second year of that last row is printed 1664, between 1560 and 1569, and is given as printed. In the rows for 1531, 1532, 1533 and 1556 the place of the comet runs on line by line from the fifth column into the sixth, words divided by the column rule, and each entry is given here whole in the fifth column; in the row for 1569 the description of the head runs on from the seventh column into the eighth (Cometes colore lucido & flammis ardentibus radians : Caudâ ad Orientem versâ.), and it is given here whole in the seventh. In the row for 1556 the seventh column carries two separate statements, one above the other. The table is set in italic, the years and counts in roman figures.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1580	October 2 / 10	To December 20, indeed to January 14, so that it lasted more than three months	In the evening at the 7th hour; then on November 14 it also became matutinal [Matutinus], up to December 6, when it was seen only in the morning.	Under the head of the leading Fish, between the zodiac and the equator, at about 5° of Pisces. As to its true place, it stood 157 semidiameters of the Earth from the Earth, so that it was in the orb of Mercury and on the border of Venus.	At first with a retrograde [retrogragrado] [recte: retrogrado] motion, fairly slow, then faster, it ran through Aries, Pisces, Aquarius, Capricorn and Sagittarius, although [quanqnam] [recte: quanquam] towards the end with a more relaxed motion, until it became almost stationary, and direct. That is, creeping forward from Aries across the equator, behind the stars in the right hand of Aquarius, to the head of Pegasus, through Equuleus, Delphinus, until it ceased to be seen under the constellation of Serpentarius.	Of a very sad, mournful and dull face, dark and lurid; exceeding in apparent size the stars of the first magnitude, indeed Venus herself. For its apparent diameter on October 15 was 16′ 30″	At first it had no tail, nor did any curls appear around it such that it could be called either a haired star or a Pogonias. In the course of time, namely on October 9, it acquired a tail, though thin and sparse, and stretched it out continually into the part opposite the Sun, though not altogether precisely.
1582	May 14	To May 18.	In the evening after sunset	Advancing from the Sun between the west and the north.	And with a retrograde and very swift motion it climbed towards the north, until it became stationary.	Horrible and of immense size.	Throwing out its tail between the right and the left shoulder of Auriga, climbing towards the Sun.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Temp. duratio-nis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1585	October 8	To November 5	In the evening at the 9th hour	In 23° 9′ of Pisces, with a southern latitude of 13° 52′	It advanced with a continuous direct motion, but gradually slower, from Pisces through Aries to the middle of Taurus, where, at about 18°, not far from the Pleiades, it ceased to be seen.	Endowed with a dark, sparse and nebulous light, which (that is, the head) in its whole form was very like the nebulous whorl of Cancer; in apparent size very nearly equal to Jupiter. In the middle of its body it was endowed with a denser light, but around its edge it was sparser and less visible.	Showing no tail or beard, except that on October 20 and 22 some thin trace of one appeared.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Temporis duratio-nis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1590	February 23	To March 6.	In the evening.	Between the asterisms of Andromeda and Aries, near the Northern Fish; but as to its true place, it stood in the highest aether, scarcely nearer than the Sun itself.	With its motion it described an arc of a great circle, and traversed half the sky, almost a quadrant.	A comet not so [?] large, shining with a pale and dark face. Its head was a little larger at the beginning than afterwards, yet it scarcely measured 3′ in diameter; from then on it gradually diminished, also somewhat dark and by no means compact, nor did it appear bright like the other stars.	It was seen to put out some small rays towards the vertex [verticem], but very thin and rather sparse, which it threw into the parts opposite the Sun.
1593	July 10	To August 21.	Before sunrise	In the cardinal solstitial signs.	By its motion it advanced from the Tropic of Cancer, from the south towards the north, or the Arctic Circle. And indeed against the sequence of the signs, from Cancer through Gemini and Taurus, so that it vanished near Cepheus.		

Years after the birth of Christ [Añi poſt Nativitatem Chriſti.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Temp. duratio-nis vel diſparitio-nis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1596	July 9		Around the first of the night, in the evening.	In the northern quarter of the sky, among the stars of Ursa Major.	Advancing gradually by its motion to the hind parts of that Bear, so that it passed through Cancer, Leo and Virgo. At the end it became stationary in longitude, its path bent, at 4° of Virgo.	Its head had the colour of Saturn.	The tail was extended into the part opposite the Sun, towards the pole of the ecliptic and the south, yet with some deviation.
1597	In July, before the 16th.	To August 9.					

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[706] The column heads are set again on this page, with the third head now reading time of disappearance (disparitionis) where the preceding pages read time of appearance (apparitionis); the punctuation of the heads again differs from page to page, and the head of the last column has no comma after Magnitudo. The years here run from 1578 to 1597. The page carries eight columns and eight ruled rows, one year to a row. In the row for 1580 the second column prints October 2 above a 10 set flush right, without a word between them. In the row for 1578 the fourth column carries, after the point of veſperi., a printed sort shaped like a closing square bracket, standing against the column rule. In the row for 1580 the sixth column prints retrogra- at a line end and grado at the head of the next line, repeating a syllable, and prints quanqnam with n where quanquam has u. The table is set in italic, the years and counts in roman figures.

Years after the birth of Christ [?] [[?]ñi poſt Na- tivi[?] [?]hriſtii]	Month and day of first ap- pear- ance [Menſ. & dies primæ ap- pari- tion.]	Du- ra- tion, or time of ap- pear- ance [Tem- pus du- ra- tio- nis vel ap- pari- tio- nis.]	Time of day or night [Tem- pus diei, vel noc- tis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1607	September 25 or 26	To November 5; it lasted 41 days.	In the evening at the 7th hour; then the whole night.	Under Ursa Major, near its following knee, towards the preceding one, a little higher than that star, towards the quadrilateral, in 30° of ♌, with a northern latitude of 36°. It had a parallax of no more than 3′, and so it stood in the aether.	Advancing with a direct motion from the front foot of the Bear, under its belly, it passed through roughly the middle of Boötes; from there it crossed Serpens, and when, under the hand of Ophiuchus, it had begun to bend its course, it at last came out at his front foot and stayed fixed in his shin. The path along which it was carried was very nearly a great circle; in the last days, however, it curved strongly towards the ecliptic. On September [?] 30 its daily motion was 13°, slower before and after; at length it became stationary and retrograde in longitude.	The face of the head was lumpy, falling short of roundness. In size greater than all the fixed stars, indeed almost equal to Jupiter himself. Its light weak, pale and watery, like that of the Moon when it stands near the shadow of the Earth. Towards the end the head grew smaller and smaller.	It had a fairly long and dense tail, and threw it, though with a deviation, into the direction opposite the Sun. Wendelen saw it like a fiery spear or a flaming sword, 7° long.

Years after the birth of Christ [?] [[?]ñi poſt Nativi[?] [?]hriſtum.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of appearance [Tempus durationis vel apparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1618 / First comet.	August 25.	To September 25.	Before sunrise, at the 3rd hour in the morning.	On September 1, a little below the left front foot of Ursa Major; turning aside towards the head of Leo, it was seen in 10°, that is, of ♌, with a northern latitude of 22°.	On September 2 it advanced with a retrograde motion against the order of the signs [antedentia] [recte: antecedentia] by 1°, and after some days it became slower.	Seen through the telescope it was shaggy, with a broad and very short head of hair, but nebulous, and with a light that did not twinkle in the least.	Throwing out a short tail, broader than the head, from the east towards the west.
1618 / Second [?]	November 10	To November 18 or 23.	At the 2nd hour before the rising [?] of the Sun.	It lay between the autumnal intersection and 18° of Libra.	Turning aside from the ecliptic into the south by about 15°. It advanced with a retrograde motion towards the south.	The head was not clearly observed by the Europeans, because of the nearness of the Sun. In Persia, however, its colour was found to be just like the smoke given off by sulphurous powder, very thoroughly refined, when it is set alight.	The tail like a curved ostrich feather. Length 45°; or, as others in Persia [?] saw it, it showed the form of a scimitar, or rather the appearance of a one-year-old palm shoot curved slightly at its tip.
1618 / Third.	November 22 or 23	To December 13.	In the morning.	It rose in the equinoctial east.	It moved not far from the vertical line, towards the north.	In colour like the star of Venus, and of equal size or a little larger.	Maned, or haired.

Years after the birth of Christ [?] [[?]ñi poſt Na- tivi[?] [?]hriſti.]	Month and day of first ap- pear- ance [Menſ. & dies primæ ap- pari- tion.]	Du- ra- tion, or time of ap- pear- ance [Tem- pus du- ra- tio- nis vel ap- pari- tio- nis.]	Time of day or night [Tem- pus diei, vel noc- tis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1618 / Fourth and last.	November 24	To 1619 January 24; it lasted 60 days.	In the morn- ing, be- fore sun- rise.	On November 29 below the scales of Libra, farther east than the line drawn between the scales, and indeed nearer to the northern scale. As to its true place, it stood in the aether: for at the beginning it was 71 semidiame- ters of the Earth from the Earth, but at the last truly farther away than the Sun itself. Indeed, towards the end its parallax was smaller than the solar parallax.	It moved forward towards the north with a certain inclination towards the west: namely through the middle of Libra and through Boötes; when it had passed beyond his face, it began to be visible all night. It then passed just above his wrist, and at a greater distance above Helice, or Ursa Major. This motion, moreover, grew slower day by day. With respect to the ecliptic it advanced from the end of Scorpio to the middle of Cancer, more than a third of the sky; at first it was southern, then northern.	Its colour somewhat pale; its outline below, that is towards the Sun, seen through the telescope, was fairly precisely round; but above, that is where the tail clung to it, uneven and as if crinkled. For the rest, the whole comet had a light not kindled in the least, or fiery, nor ruddy or lively, but languid, whitish, nebulous and dark. Sometimes, however, it twinkled faintly. In the centre of the head at first a single nucleus was observed, which then broke up into three, and finally into more and more smaller ones; so that in fact it showed a continually changing face, both in its apparent size and in its true size.	Under the head it was very narrow; around the middle and the end, fairly broad. It stretched out with a curving, now towards the south, now towards the north, yet not precisely into the direction opposite the Sun. Through its middle, along its length, ran a clear and distinct line, like the pith of a tree. Not seldom the whole coma twinkled and wavered; then rays were shot out from the head and suddenly drawn back. Its length was sometimes 45, 60, 75, indeed 104°, and its breadth 3°. Its colour near the head was fiery and ruddy, but towards the end pale and whitish.

Years after the birth of Christ [?] [[?]ñi poſt Na- tivi[?] [?]hriſti.]	Month and day of first ap- pear- ance [Menſ. & dies primæ ap- pari- tionis.]	Du- ra- tion, or time of ap- pear- ance [Tem- pus du- ra- tio- nis vel ap- pari- tio- nis.]	Time of day or night [Tem- pus diei, vel noc- tis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1647	November 29.	For two days.	In the evening at $8^{h}\ 30^{m}$.	In the constellation of Berenice, not very far from the left shin of Boötes, 5° away; from Arcturus about 10°; in 8° of Libra, with a northern latitude of 26°.	It advanced against the sequence of the signs from the head, that is, of Boötes, towards the ecliptic and Spica.	A little smaller than Arcturus, yet fairly bright and shining.	It showed a tail raised upwards towards the zenith, about 12° long, like a broom; for the rest it was quite conspicuous and bright, especially where it issued from the head, but at its end sparser and more spread out.

[707] The table continues with its column heads set again in the words of p. 1037, the third head again reading time of appearance (apparitionis) where p. 1038 reads time of disappearance (disparitionis), and the last head again with a comma after Magnitudo. The first letter of three lines of the first head stands in the fold of the binding and cannot be seen. The years here run from 1607 to 1647. The page carries eight columns and six ruled rows, one year to a row; the four rows for 1618 each add an ordinal to the year (the first, second, third, and fourth and last comet of that year), and the first letter of two of these ordinals stands in the fold. In the row for 1618, First comet, the motion column prints antedentia where the phrase in antecedentia (against the order of the signs) has a c. In the row for 1618, Fourth and last, the place column prints the distance as 71 with a 1 of a different, raised form from the other figures of the page, and prints lanceis where lances is expected. In the row for 1647 the time column prints the minutes as 30 with a single stroke. The table is set in italic, the years and counts in roman figures.

Years after the birth of Christ [Añi poſt Nativitatem Chriſtit.]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Temporis duratio-nis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1652	December 20.	To January 10.	In the evening, at the 6th hour.	In 9° of Gemini, with a southern latitude of 31°, not far from Regel [Rigel] of Orion; so that with this star and the one above the foot of Orion in Eridanus it formed a roughly equilateral triangle. For the rest, it stood in the aether. For even when it was nearest to the Earth, it was 110 semidiameters of the	It went in a continuous retrograde course, namely from the more southern parts to the northern: that is, through Lepus, the foot of Orion, Taurus, to the Pleiades, as far as Perseus; not in a straight line but obliquely, from Hyper-Euronotus to Hypocircius; under a circle very nearly a great circle, and inclined to the ecliptic and the equator; with a daily motion of 11° 16′ at the beginning, but of 30′ at the last. Over its whole	The head was round, barely somewhat smaller than the full Moon. Its light seemed pale, dull and less bright, like that of the Moon covered with a very thin cloud. In the body itself very diverse nuclei were detected with the telescope, changing day by day and altering their position. Moreover, just as the apparent size did not stay the same continually, so likewise the true size of the diameter: for the former was 30′ at the beginning, the latter 825 German	At first it stretched out its tail towards Subsolanus, into the direction opposite the Sun (though with some deviation), towards the hilt of the sword in Orion, like a cone ending in a very thin point, with a length of 7°. It was moreover whitish and somewhat dark, thin, and endowed with no spreading or shaggy rays; it seemed now longer, now shorter, sadder and darker; until on January 7 it

Years after the birth of Christ [Añi poſt Nativitatem Chriſti]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1661	February 3	53 days, to March 28.	In the morning, at $5^{h}\ 47^{m}$.	Towards Subsolanus. Below Delphinus, between the heads of Aquila and of Equuleus, in 10° of ♒, with a northern latitude of 22°. It stood in the aether itself: at the beginning it was 2000, at the last 9000 semidiameters of the Earth away from the Earth, so that it stood higher than the Sun itself.	Its course was from Eurus to Zephyrus, namely through the head, the neck and the greater part of the lower wing of Aquila, on a track almost parallel to the ecliptic and the equator, and retrograde; it went, however, by no means under a great circle, but under a curved orbit, that is, as to its apparent motion; but as to its true motion, in a nearly straight path, and indeed within the annual orbit, with a fairly swift daily motion, although one continually decreasing,	The head was round, of yellowish colour, bright and conspicuous, yet it was endowed with no quivering light. In the centre it showed at first a reddish nucleus, very nearly equal to Jupiter himself, which a much more diluted and thinner matter surrounded. In the course of time, however, an evident change in this nucleus was detected.	It stretched out a remarkable tail of six degrees, more or less, towards Delphinus, more compressed at its issue at the head than around its end. And indeed into the quarter opposite the Sun, but with some deflection.

Years after the birth of Christ [Añi poſt Nativitatem Chriſti]	Month and day of first appearance [Menſ. & dies primæ apparitionis.]	Duration, or time of disappearance [Temporis duratio-nis vel diſparitio-nis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo,Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo Forma, Situs.]
1664	December 14	Almost three months.	In the morning, at the 5th hour; then in the evening on December 29.	At the beak of Corvus, in 8° of Libra, with a southern latitude of 22°; but as to its true seat, it stood in the highest aether. For its parallax was 30″ at the beginning, 4′ in the middle and 16″ at the end, so that it was at first 3500, then 1000, and at the end 12000 semidiameters of the Earth away from the Earth; and so, around its last appearance, it was found to be more remote than Mars itself.	With a retrograde motion it advanced from Corvus through Hydra, Navis, Canis Major, Lepus, Eridanus, the head of Cetus, as far as Aries, yet under a circle not altogether a great one: for around the end and the station it turned aside notably towards Aquilo. Hence the angle of inclination and the node varied continually. It thus traversed five signs of the zodiac and more, that is, Libra, Virgo, Leo, Cancer, Gemini, Taurus, as far as Aries; but in respect of the apparent orbit, 154°. In its true path it went outside the annual orbit, at an inclination of 17°. In this path it crossed in one day at first 198, but then 134 semidiameters of the Earth, so that its true motion decreased in due proportion right up to the end.	The head was fairly conspicuous, of yellowish colour [zoloris] [recte: coloris], and of a rather weak and dull light. In the centre a certain bright light was detected, surrounded by another, darker and thinner one; with the telescope, however, the head was found to consist of very many particles, or corpuscles, with other, subtler matter of differing density scattered among them in various ways. This matter, together with the nuclei themselves, was found first to condense and then to disperse again. In apparent size the head grew at the beginning, but then decreased right up to the end, as it became thinner and paler. As to its true size, the diameter of the comet was at the beginning almost six times greater than the diameter [dimetiens] of the Earth.	At first it threw out towards Favonius a remarkable tail of 14°, and fairly bright, but [?] spreading out around its end. In the course of time this tail was seen now longer, now shorter, and on a certain day also curved. On December 28 it showed its coma held quite upright, like the tail of a peacock; from which [?] time onwards it began to put it out towards the east. Yet throughout its whole duration it directed it towards [?] the stars of Gemini, that is, into the quarter opposite the Sun [?], though continually with some deviation, at first northern, then southern. Towards the end it not [?] rarely shed its tail completely; sometimes it also recovered it again.

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[708] The column heads are set again on this page in the words of p. 1038, the third head again reading time of disappearance (disparitionis) where p. 1039 reads time of appearance (apparitionis), and the last head again with no comma after Magnitudo. The years here run from 1652 to 1664. The page carries eight columns and three ruled rows, one year to a row. In the row for 1664 the ends of several lines of the last column lie under the edge of the facing leaf where the book is bound, so that the last letters of some words are not seen; the English marks the words whose sense depends on them. The table is set in italic, the years and counts in roman figures.

Years after the birth of Christ [Añi poſt Chriſti Nativitatem.]	Month and day of first appearance [Menſ. & dies primæ apparitionis]	Duration, or time of disappearance [Tempus durationis vel diſparitionis.]	Time of day or night [Tempus diei, vel noctis.]	Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.]	Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.]	Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.]	Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]
1665	April 6	14 days	In the morning, at $1^h\ 30^m$.	Near Hellespontium, right on the breast of Pegasus, in 15° of Pisces, with a northern latitude of 27°. Its parallax, which was 69″ at the beginning, gradually decreased to 41″. Hence at the beginning [principiè] [recte: principiò] it was 3000, and towards the end 5000 semidiameters of the Earth	It advanced through Pegasus, under the head of Andromeda, through the Northern Fish, towards Aries; and indeed with a continuous direct motion, most closely proportioned: at the beginning 4° 6′ in one day, but at the last 2° 23′; by which the ecliptic, from Pisces as far as Taurus. The path of this comet ran within the	The head was round, of yellowish colour and of a lively light. With the telescope a single round nucleus, and only one, was detected in its centre, very bright and of conspicuous size, shining like gold; another, thinner and even matter surrounded it. This matter, however, became daily more pointed at the front of the	At the beginning the tail was about 17° long; spread out around its end, it was thrown out between the mouth and the preceding foot of Pegasus, towards the west. Moreover, at its very issue from the head it was very dense and bright, of almost the same density as the matter itself surrounding the head; but around its point very thin and diluted. It shone with this appearance for almost the whole time of its duration, except that at times it grew to 25°, and also more often showed a

Years after the birth of Christ [Añi poſt Chriſti Nativitatem.] | Month and day of first appearance [Menſ. & dies primæ apparitionis] | Duration, or time of disappearance [Tempus durationis vel diſparitionis.] | Time of day or night [Tempus diei, vel noctis.] | Quarter of the sky, and place of the comet [Plaga mundi, & Locus Cometæ.] | Motion of the comet: direct or retrograde; slow or swift [Motus Cometæ directus, aut retrograd. Tardus vel velox.] | Size, shape and colour of the comet's head [Capitis Cometæ Magnitudo, Figura, Color.] | Size, form and position of the tail [Caudæ Magnitudo, Forma, Situs.]

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THE END.
Salvation, and honour, and glory, and power to the Lord our God.

Index of the Principal Subjects of the Whole Work [INDEX Rerum præcipuarum totius Operis.]

A.

- In the time of Abraham a comet shone [ABrahami tempore Cometes fulſit.], 794.
- Acontiae, 440, 804.
- Acontiae: where they take their name from [Acontiæ unde nomen accipére.], 881.
- The action of rays: direct action is far stronger than oblique [Actio radiorum directa fortior longè eſt, quàm obliqua.], 575.
- Advice to astronomers [Admonitio ad Aſtronomos.], 319.
- Objects are perceived more distinctly with an oblique glance than with a direct one [Adſpectu obliquo diſtinctiùs objecta, quàm recto percipiuntur.], 332.
- Precession of the equinox [Æquinoctii præcesſio.], 135.
- An aerial comet: how long it would persist [Aëreus Cometa quamdiu perſiſteret.], 715.
- Air is no obstacle to falling bodies [Aër cadentibus nil obſtat.], 573.
- An aerial comet, if it were visible for 6 months: how great a distance it would cover in one day [Aëreus Cometa ſi per 6 Menſes esſet conſpicuus, quantum itineris ſpatium unâ die conficeret.], 715.
- A more turbid air, and a lower position of comets, can sometimes produce twinkling [Aër fœculentior, decliviorq́; Cometarum Situs, ſcintillationem nonnunq. inducere posſunt.], 510.
- Air of varying kind also gives the phenomenon a varying colour [Aêr varius, varium quoq́ue phænomeno induit colorem.], 330.
- Every age has something to do [Ætas omnis, quod agat, habet.], 733.
- Aethereal bodies: whether they can eject so much matter without loss that so many immense adventitious bodies could be generated [Ætherea corpora, an tantum materiæ ſine detrimento ejicere posſint, quò tot immenſa corpora aſcititia generari queant ?], 393.
    - bodies turn about an axis [corpora circa axem volvuntur.], 371, 373.

709 The column heads are set again on this page in the words of p. 1037, the third head reading time of disappearance (disparitionis) as on pp. 1038 and 1040, and its first word given in full as Tempus. The first head orders its lines differently from the preceding pages, setting Christi before Nativitatem; the second head prints parition without a point. The page carries eight columns and a single ruled row, for the year 1665, which closes the table. In the place column the word for at the beginning is printed principiè. The tail column ends at the foot rule without a closing point.

    - that these bodies consist of heterogeneous parts is not so easy to prove [corpora ex heterogeneis conſtare partibus, non adeò proclive eſt probatu.], 358.
    - bodies are driven round unceasingly in an orbit [corpora indeſinenter in Orbem aguntur.], 644.
    - bodies: by what means they breathe out evaporations [corpora, quâ ratione evaporationes exſpirent.], 357.
    - that bodies move along a great circle, even Aristotle himself admits [corpora ſub circulo maximo incedere,ipſe etiam Ariſtoteles fatetur.], 132.
    - temporary bodies never attain the perfection of coeval bodies [corpora temporaria, ad perfectionem coævorum corporum nunquam perveniunt.], 393.
    - all bodies continually breathe out effluvia [corpora univerſa continuò exſpirant effluvia.], 644.
    - not all bodies rotate equally fast about an axis [corpora univerſa non æquè velociter circa axem rotantur.], 373.
    - all bodies eject and breathe out more matter than the Earth does [corpora univerſa plus materiæ, quàm terra ejiciunt, atque exſpirant.], 394.
    - all bodies undergo a reciprocal influence, each in its own way [corpora univerſa reciprocum patiuntur ſuo modo influxum.], 372.
    - effluvia: how they move in atmospheres [effluvia quomodo in atmoſphæris moveantur.], 420.
- Aethereal evaporations: how they leave their bodies [Æthereæ evaporationes quomodo à corporibus ſuis diſcedunt.], 644.
    - evaporations: how they are set in motion into the atmosphere [evaporationes quomodo in atmoſphæram commoventur.], 644.
    - exhalations sometimes produce particular meteors in the atmosphere [exhalationes nonnunquam peculiaria in atmoſphærâ producunt meteora.], 647.
- That the aether too has its own density, Cysat strives to affirm [Ætherem & ſuam habere denſitatem, Cyſatus affirmare contendit.], 475.
- The poles of the atmospheres of aethereal bodies: how they lie over the ecliptic and the equinoctial of the world [Æthereorum corporumAtmoſphæræ Poli, quomodo Eclipt[[i/t]]cæ & æquinoctiali Mundi incubant?], 707.
    - the effluvia of these bodies *congreguntur* and congregate more readily and more quickly in the south and the north [corporum effluvia,procliviùs citiusq; in Auſtro & Septentr. congreguntur & congregantur.], 717.

- Parts of aethereal bodies sometimes admit generation and corruption, but the whole is preserved for ever [Æthereorum corporum partes, nonnunquam generationem & corruptionem admittunt, totum verò in æternum conſervatur.], 394.
- Every aethereal body has its own particular power of preserving itself [Æthereum corpus omne, ſingularem ſe conſervandi potentiam habet.], 382.
- The substance of the aether according to Cysat: what it is like [Ætheris ſubſtantia juxta Cyſatum qualis.], 476.
- The aether is distinguished from the air only by its purity [Æther non niſi puritate ab aêre diſtinguitur.], 355.
- The aether has no refraction at all [Æther refractione omninò caret.], 370.
- The aggregation of matter: how it takes place [Aggregatio materiæ quomodo fiat.], 564.
- Alteration and change of the cometary body in 1618, most evident [Alteratio & mutatio corporis Cometici 1618 evidentisſima.], 885.
    - most evident, of the head of the comet of 1661 [evidentisſima Capitis Cometæ 1661.], 722,893.
    - of the solar body, and the greatest vicissitude [Solaris corporis & vicisſitudo maxima.], 359.
- Celestial alterations and corruptions: how they are to be understood [Alterationes & corruptiones cœleſtes quomodo accipiendæ ?], 354.
- Alterations, generations and corruptions: how they occur in the heavens [Alterationes, Generationes & Corruptiones quomodo in cœlo fiunt.], 355.
    - that they occur in the body of a comet, Riccioli also maintains [in Corpore Cometico dari, Ricc. etiam ſtatuit.], 882.
    - of the planets: why they are not as open to everyone's view as the solar and lunar ones [Planetarum, cur non æquè ac Solares & Lunares cuivis ſint obviæ ?], 368.
- Whether individual comets also show a similar motion [An Cometæ ſinguli,ſimilemetiam referant motum?], 112.
- Angles of the comet of 1652 serving the diagram [Anguli Cometæ 1652 Schemati inſervientes.], 593.
    - of the ecliptic and the orbit: how great the variation [Elipticæ& Orbitæ variatio quanta.], 111.
    - demonstration of the inclination and of the node [inclinationis atque Nodi demonſtratio.], 115.
    - of the obliquity: a most evident variation in the comet of 1665 [obliquitatis in Cometâ 1665 evidentisſima Variatio.], 770.
    - variation of the obliquity of the comet of 1665: how great it was [obliquitatis variatio Cometæ 1665 quanta extitit.], 771.
    - of the orbit and the equator: how manifold the variation [orbitæ & æquatoris variatio quotuplex.], 564.

    - of the orbit: the account of its variation [orbitæ variationis ratio.], 564.
    - variation of the orbit, set out in a table [variatio orbitæ Tabula incluſa.], 112.
- That the angle of inclination remained invariable, Tycho tries to show by various examples [Angulum inclinationis invariabilem extitisſe, Tycho diverſis exemplis oſtendere conatur.], 113.
    - of the orbit, and the node, as fixed: which among the authors have held this [Orbitæ fixum, Nodumq; inter Auctores, quinam ſtatuerint.], 113.
    - of the path and the plane of the ecliptic: the method of finding it [Trajectoriæ & plano – Eclipticæ inveniendi ratio.], 596.
- The angle at the intersection of the lines of sight is equal to the motion in longitude [Angulus ad ſectionem viſoriarum motui longitudinis æquatur.], 638.
- The angle of the comet of 1652, of the orbit and the equator, and also the node, was subject to variation [Angulus Cometæ 1652, orbitæ & æquatoris, nec non Nodus variationi fuit obnoxius.], 111.
    - of the cometary disc: from what cause it varies [Diſci Cometici unde varietur ?], 770.
    - of inclination only appears to vary [Inclinationis apparet tantùm variari.], 134.
    - of inclination of the comet of 1607 was likewise variable [Inclinationis Cometæ 1607 itidem variabilis extitit.], 120.
    - of inclination in the comet of 1590 was stable, in Tycho's opinion [Inclinationis ex mente Tychonis in Cometâ 1590, fuit ſtabilis.], 116.
    - of inclination in any planet: how great it is [Inclinationis in quocunque Planetâ quantus ſit.], 134.
    - of inclination of the planets: why it is variable only as to appearance [Inclinationis Planetarum, cur tantùm quoad apparentiam exiſtat variabilis ?], 135.
    - of the orbits of comets: whether it varies [Orbitæ Cometarum an varietur ?], 104, 133.
- The angle of the orbit and the equator of the comet of 1652, and also the node, was subject to variation [Angulus Orbitæ & Æquatoris Cometæ 1652, nec non Nodus variationi fuit obnoxius.], 112.
    - of the orbit and the ecliptic, and also the node, of the comet of 1661 [Orbitæ & Eclipticæ, nec non Nodus Cometæ 1661.], 739.
    - parallactic, between Danzig and Digne, with the comet 3 semidiameters of the Earth away from the Earth [parallacticus inter Dantiſcum & Diniam, Cometâ à Terrâ 3 Sem. T. remoto.], 159.
    - parallactic, between Danzig and Digne: how great it was in the comet of 1652 [parallacticus inter Dantiſcum & Diniam, quantus extiterit in Cometâ 1652.], 161.

    - parallactic, between Danzig and Königsberg, with the comet at a distance of 20 miles from the Earth [parallacticus inter Dantiſcum &Regiomont.Cometâ verſante in Diſtantiâ 20 à Terrâ mill.], 156.
    - parallactic, between Paris and Danzig: how great it would have been with the comet in the air [parallacticus inter Lutetiam & Dantiſcum, Cometâ exiſtente in aere, quantus extitisſet.], 155.
- Certain selected remarks on the calculation to be made from distances, most noteworthy [Animadverſiones quædam ſelectæ, circa calculum ex Diſtantiis ſuſcipiendum, maximè notabiles.], 210.
- Points to note when a fixed star views the comet and its orbit at a right angle [Animadvertenda,quando Fixa Cometam ejusq́; Orbitam ad angulum Normalem adſpicit.], 178.
- Tycho's notes on the new star that arose in Cassiopeia [Annotationes Tychonis ſuper novam Stellam in Casſiopeâ exortam.], 375.
- The size of the little handles of Saturn [Anſularum Saturni magnitudo.], 372.
- Aphorisms on comets [Aphoriſmi Cometarum.], 433.
- The apparent diameter of the comet of 1652: how it would have grown at those various distances from the Earth, if the true diameter had always stayed the same [Apparens Diameter Cometæ 1652,quâ ratione crevisſet, ſi vera permanſisſet ſemper eadem,in diverſis illis à Terrâ remotionibus.], 347.
- The appearance of the comet of 1577 [Apparitio Cometæ 1577.], 579.
- Appearances of sunspots are sometimes sudden and abrupt [Apparitiones Macularum Solarium ſubitaneæ interdum ſunt, & repentinæ.], 711.
- Apian's observation of the comet, 1531, 1533, 1539 [Appiani obſervatio Cometæ, 1531, 1533, 1539.], 846,847, 849.
- Apian was the first to notice the directions of the tails [Appianus primus extitit, qui caudarum directiones animadvertit.], 461.
- Water flowing against the tiller is a moving force [Aqua ad temonem alluens, vis movens eſt.], 578.
- The area of the whole cometary body of 1652 [Area totius corporis cometici 1652.], 334.
- A single argument for the place of comets, but amply sufficient to overturn the opinions of the Peripatetics [Argumentum pro ſede Cometarum unicum, ſed ad convellendas Peripateticorum opiniones abundè ſufficiens.], 317.
- Aristotle observed a comet whose tail stretched across almost a third part of the sky [Ariſtoteles Cometam obſervavit, cujus cauda ad tertiam ferè cœli partem protenſa fuit.], 797.
- The opinion of Aristotle and the Peripatetics on comets [Ariſtotelis & Peripateticorum de Cometis opinio.], 352.
    - Boulliau holds that the books *On the Heavens* are spurious [Libros de cœlo ſuppoſititios eſſe putat Bulliald.], 329.

- A board plunged straight into water does not stay upright at all, and why? [Asser in aquam rectà immersus, erectus minimè consistit, & quare. ?], 419.
- New stars sometimes arise in the aether, and set again [Astra nova nonnunquam in æthere oriuntur,rursusq; occidunt.], 374.
- The foundation of astrology [Astrologiæ fundamentum.], 718.
- The author leaves astrological matters concerning comets to others [Astrologica de Cometi Auctor aliis committit.], 719.
- The author does not agree with the astrologers regarding the nativity of comets [Astrologis Auctor non assentit ratione Comet[[a/á]]rum nativitatis.], 427.
- What usually happens to astrologers [Astrologis quid plerumque evenire assolet.], 428.
- Most astronomers delight in empty predictions [Astronomi pleriq; vanis oblectantur prædictionib.], 121.
- What hindered astronomical speculations [Astronomicas speculati[[o/u]]nes,quid impediverit.], 437.
- There is certainly an atmosphere around comets [Atmosphæra circa Cometas omninò datur.], 477.
    - the cometary atmosphere imitates the atmosphere of the Earth [cometica, atmosphæram terrestrem imitatur.], 498.
    - the cometary one: whether it has fixed limits of density? [cometica, num certos densitatis possideat limites?], 501.
    - of Jupiter and its companions [Jovis ejusq; C[[o/ɔ]]mitum.], 370.
    - of the Moon: it exceeds in extent both our twilight atmosphere and the shadow of the Earth [Lunæ, tam nostram atmosphæram crepusculinam, quàm umbram terrenam vastitate vincit.], 365.
- Celestial atmospheres: at what elevation of the pole, and in what way about the poles of the world, they rotate [Atmosphæræ cœlestes sub quâ elevatione Poli, quà Polos Mundi rotentur.], 716.
    - the constitution of the cometary atmosphere brings about variation in the tails of comets [cometicæ constitutio, variationem caudis Cometarum inducit.], 541.
- The helix of the atmosphere is smallest of all around the pole [Atmosphæræ helix circa Polum omnium minima est.], 671.
    - the shell-shaped line is always greatest around the equator [linea conchalis semper maxima est circa Æquatorem.], 671.
    - lunar: proof [lunaris probatio.], 364, 365.
    - of the planets: not all complete their revolutions equally fast and in an equal span of time [Planetarum universæ, non æque velociter atque æquali temporis spatio circumgyrationes suas peragunt.], 695.
- That there is an atmosphere around comets, the sunspots demonstrate [Atmosphæram circa Cometas dari, maculæ demonstrant Solares.], 477.

- around the Moon: it is proved to exist [circa Lunam eſſe probatur.], 363.
- around the Sun: its existence is demonstrated by the author [circa Solem eſſe ab Auctore demonſtratur.], 361.
- that there is a lunar one is inferred from solar eclipses [lunarem dari, ex deliquiis Solaribus infertur.], 365.
- Cysat also detected a lunar one [lunarem etiam Cyſatus deprehendit.], 366.
- by what means a new comet emerges [quâ ratione recens Cometa exit.], 672.
- all celestial bodies have their own [ſuam habent univerſa corpora cœleſtia.], 371.
- every aethereal body has its own, in which generations and alterations occur [ſuam quodvis corpus æthereum habet, in quâ generationes & alterationes accidunt.], 357.

- The author demonstrated the place of the comet of 1652 accurately enough, and so satisfied the distinguished Riccioli [Auctor Cometæ 1652, ſedem accuratè ſatis demonſtravit, atque ita Cl. Ricciolo ſatisfecit.], 317.
  - imagines a comet that runs through the whole zodiac in a short space of time and stays in the aether for an entire year [Cometam fingit, qui brevi temporis ſpatio totum Zodiacum percurrit, ac per integrum annum in æthere hæret.], 636, 637.
  - holds that comets are temporary bodies, and by no means eternal [Cometasſtatuit corpora eſſe temporanea, & minimè æterna.], 562.
  - trusts that in time weightier arguments for the motion of the Earth will come forth [confidit cum tempore prægnantiora argumenta pro motu Terræ proditura.], 780.
  - is confident that he will demonstrate that there are celestial generations and alterations [confidit ſe demonſtraturum dari generationes & alterationes cœleſtes.], 358.
  - does not agree with Kepler on the matter of the tails [cum Keplero de caudarum materiâ non conſentit.], 481.
  - does not agree with Tycho on the angle of inclination of the comet of 1577 [cum Tychone non conſentit ſuper angulum inclinationis Cometæ 1577.], 114.
  - why he undertook, with God, to compile a new catalogue of the fixed stars [cur ſuſceperit cum D E O novum condere Fixarum catalogum.], 400.
  - why he undertook to defend the trajection [cur Trajectionem defendendam ſuſceperit.], 588.
  - on the motion of comets he dissents from other philosophers [de Cometarũ motu à Philoſophis aliis diſſentit.], 560.
  - wonders that not more comets come into our view [demiratur Cometas nobis non plures in adſpectum venire.], 405.

- demonstrates that the hypothesis constructed from tangents sometimes deviates enormously from the heavens themselves [demonſtrat hypotheſin ex tangentibus conſtructam enormiter quandoque ab ipſo cœlo deviare.], 780, 781.
- demonstrates that there can be so much matter around comets as to produce very long tails [demonſtrat tantùm materiæ circa Cometas dari poſſe, ad caudas longiſſimas procreandas.], 481,482.

- The author set out the history of the later comets more fully [Auctor Hiſtoriam Cometarum poſteriorum copioſiùs expoſuit.], 793.
  - to oblige the Peripatetics, removes comets to 2580 miles from the Earth [in gratiam Peripateticorum Cometas ad 2580 mill. à Terrâ removet.], 157.
  - although he removes comets to 2580 miles from the Earth, yet all the difficulties are not avoided [licet Cometas ad 2580 mill. à Terrâ removeat, omnes tamẽ inconvenientiæ haud evitantur.], 157.
  - resolved not so much to refute all the contrary opinions of the philosophers as to confirm his own view [non tam omnes contrarias opiniones Philoſophorum refellere, quàm ſuam ſententiam confirmare ſtatuit.], 474.
  - places all comets in the aether [omnes Cometas in æthere ſtatuit.], 318, 352.
  - by means of a straight path freed very many comets from all difficulties [ope Trajectoriæ rectæ plurimos Cometas ab omnibus inconvenientiis exemit.], 591.
  - tried to save comets by means of circles, but in vain [operam dedit ut Cometas ſalvaret per circulos, ſed fruſtra.], 590.
  - undertook the calculation of the parallaxes, though most tedious, with the greatest eagerness [parallaxium calculum licet faſtidioſiſſimum, cupidiſſimo tamen animo ſuſcepit.], 239.
  - gave the images of very many comets [plurimorum Cometarum effigies tradidit.], 441.
- The author: in what sense what he reported about the hypothesis from tangents is to be taken [Auctor quæ de hypotheſi ex Tangentibus retulit, quo ſenſu accipienda.], 789.
  - by what means he saves the comet of 1472 [quâ ratione Cometam 1472 ſalvat.], 611.
  - by what means he investigated the parallaxes of the comet of 1664 [quâ ratione parallaxes Cometæ 1664 exploraverit.], 756,757.
  - to what end he wrote the history of comets, and what he chiefly attended to in it [quem in finem Hiſtoriam Cometarum conſcripſerit, & quid præcipuè in illâ attenderit.], 791,792.
  - does not side with Tycho on the curvature of the tails [Tychoni non adſtipulatur de caudarum curvaturâ.], 493.

- Authors: on what they agree concerning the tails of comets [Auctores de Cometarum caudis in quo conveniunt.], 475.
    - different authors, from completely different observations, deduce almost the same motion after the maximum velocity of comets [diverſi ex obſervationibus planè diverſis,poſt maximam Cometarum velocitatem, eundem ferè deducunt motum.], 784.
    - different authors stray widely from the truth in the same calculation [diverſi in eodem calculo abundè à vero exorbitant.], 785,786.
    - though they differ among themselves as widely as possible as to the perigee, they agree accurately as to the motion [inter ſe quà Perigæum quàm longisſimè disſidentes, quà motum accuratè conveniunt.], 784,785.
    - most of them agree on this concerning the tails of comets, that the tails are projected toward the parts opposite the Sun [pleriq́ue in hoc de Cometarum caudis conveniunt, quod caudæ in partes Soli oppoſitas projiciantur.], 475.
    - who first of all noticed the deviation of the coma [qui deviationem Comæ omnium primò animadverterunt.], 484.
    - who hold that there are exhalations and effluvia from the aethereal bodies [qui ſtatuunt exhalationes & effluvia dari ex corporibus æthereis.], 357.
    - the ancients: which of them held that comets consist of various small bodies [veteres, quinam Cometas ex diverſis corpuſculis conſtare ſtatuerint.], 351.
- From his hypothesis the place and course of the path, and consequently also the distance, are at once clear to the author [Auctori ex ſuâ hypotheſi illicò patet Trajectoriæ locus ductusq́;, & per conſequens etiam intervallum.], 778.
- The author's reply to the argument of the Reverend Father Pardies against the motion of the Earth [Auctoris ad argumentum R. P. Pardies contra motum Terræ reſponſio.], 779,780.
    - calculation and diagram of the theory of 1607 [calculus & Schema Theoriæ 1607.], 623.
    - calculation constructed according to tangents comes somewhat nearer to the maximum velocity than that of the other authors [calculus juxta Tangentes conſtructa maximæ velocitati aliquantò propiùs accedit, quàm reliquorum Auctorum.], 785.
    - advice to be duly observed before undertaking the parallaxes [conſilium ante parallaxium aggreſſionem probè obſervandum.], 169.
    - advice on finding out the difference of the parallaxes [conſilium in eruendâ parallaxium differentiâ.], 199.
    - advice on how the hypothesis from tangents might be helped [conſilium, quâ ratione hypotheſi ex Tangentibus ſubveniri poſſit.], 783.

- opinion on the angle of inclination and the node of the comet of 1618 [de Cometæ 1618 inclinationis angulo, Nodoq́; ſententia.], 118, 133.
- opinion, established by sure reasons, on the true place and seat of comets [de Cometarum vero loco & ſede certis rationibus ſtabilitâ ſententia.], 135, 137, 151.
- opinion on the movement and the force of the rudder [de commotione, & virtute Gubernaculi ſententia.], 577.
- opinion on the curvature and obliquity of the tails [de curvaturâ,& obliquitate caudarum ſententia.], 495.
- opinion on the steering of ships [de directione navium ſententia.], 581.
- opinion on the eclipse of the Sun seen at the time of the Passion of Christ [de Eclipſi Solis tempore Paſſionis Chriſti viſa, ſententia.], 540.
- summary of his opinions on the generation and corruption of comets [de generatione, & corruptione Cometarum ſententiæ ſumma.], 383.
- description of the solar body [deſcriptio corporis ſolaris.], 359.
- contrary opinion on the constancy of the angle of inclination in the comet of 1590 [de ſtabilitate anguli inclinationis in Cometâ 1590, contraria ſententia.], 116.
- opinion on the new star in the neck of Cetus [de Stellâ novâ in collo Ceti ſententia.], 378.
- opinion on the vibration and fluctuation of the tails [de vibratione & fluctuatione Caudarum ſententia.], 511.

- An ephemeris of the three later comets, constructed from tangents [Ephemeris trium poſteriorum Cometarum ex tangentibus conſtructa.], 782.
- The opinion of the author and of others on the variation of the angles of the orbit and the ecliptic, and also of the node [Auctoris & aliorum ſententia de variatione Angulorum Orbitæ & Eclipticæ, nec non Nodi.], 133.
- The author's genuine description of comets [Auctoris genuina Cometarum deſcriptio.], 390.
  - judgment on Tycho's observations [Judicium de obſervationibus Tychonis.], 114.
  - judgment on his own cometographic work [Judicium de opere ſuo Cometographico.], 437.
  - judgment on Kepler's theorems on the motion and trajection of comets [Judicium de Theorematibus Kepleri, de motu & Trajectione Cometarum.], 641.
  - hypothesis of the comet of 1661 reduced to a table [hypotheſis Cometæ 1661 in Tabellam redacta.], 713.

- his hypothesis saves all the appearances [hypotheſis omnes ſalvat apparentias.], 339,343,347.
- his hypothesis, given exquisite observations, determines accurately enough the parallaxes of comets and their distances from the Earth [hypotheſis parallaxes Cometarum, eorumq́; à Terrâ intervalla,datis exquiſitis obſervationibus, ſatis accuratè definit.], 750.
- his *Machina coelestis* will appear shortly [Machina Cœleſtis propediem prodibit.], 401.
- observations of the comet of 1661 [obſervationes Cometæ 1661.], 725.
- observations of the new star in the neck of Cetus [obſervationes Stellæ novæ in collo Ceti.], 377.
- observation of a certain singular sunspot [obſervatio ſingularis cujusdam maculæ Solaris.], 424.
- opinion on the motion of comets [ſententia de Cometarum motu.], 648.
- opinion on the method of computing parallaxes according to Regiomontanus [ſententia de methodo computandi parallaxes ſecundùm Regiomontanum.], 295.
- it takes nothing from his opinion that comets sometimes traverse the sublunary air [ſententiæ nihil derogat, Cometas aêrem ſublunarem nonnunquam trajicere.], 612.
- method of investigating parallaxes [parallaxes inquirendi methodus.], 168.
- whether his theory makes the motion of comets much swifter [Theoria an Cometarum motum multò reddat velociorem.], 702.
- his theory agrees very closely with the heavens [Theoria cum cœlo perquàm convenit.], 749.
- the more recent comets also submit to his theory [Theoriæ, recentiores quoq́ue Cometæ ſe ſubjiciunt.], 774.
- his theory is shown to agree excellently with the observations and phenomena of the comet of 1577 [Theoriam cum obſervationibus, & phænomenis Cometæ 1577 optimè convenire commonſtratur.], 618.
- his theory is proved by a clear argument not to be so very absurd [Theoriam non usq́ue adeò esſe abſurdam evidenti probatur argumento.], 713.

- Various opinions of authors on the direction of the tails [Auctorum de directione caudarum variæ ſententiæ.], 462.
  - disagreement about the parallaxes of the planets [disſenſio circa Planetarum parallaxes.], 314.
  - disagreement of various authors about the angle of inclination and the node of the comet of 1618 [diverſorum de inclinationis angulo, Nodoq́; Cometæ 1618 disſenſio.], 116.

    - some hold that the tails of comets point not entirely straight away from the Sun, but with a certain inclination and declination [nonnulli caudas Cometarum non in directum omninò à Sole,ſed cum certâ quâdam inclinatione & declinatione vergere ſtatuunt.], 462.
- With what speed birds are carried along [Aves quantâ celeritate ferantur.], 702.
- A perceptible increase of the cometary body [Augmentatio ſenſibilis corporis cometici.], 885.
- In birds the wings, and in fish the fins, act like oars [Avibus alæ & piſcibus pinnæ inſtar remorum ſunt.], 587.
- In birds and fish the tail acts like a tiller [Avibus & piſcibus cauda temonis inſtar eſt.], 587.
- Auzout's opinion on investigating the motion of comets from the hypothesis built on tangents [Auzoutii ſententia de inveſtigando Cometarum motu ex hypotheſi per Tangentes exſtructâ.], 783,784.
- Axioms on the motion of comets [Axiomata de Cometarum motu.], 644.
    - on the refraction of rays [de radiorum refractione.], 497.
    - of parallaxes, as to addition and subtraction, when fixed stars lie beneath the orbit itself or near it [parallaxium ratione additionis & ſubtractionis, quando Stellæ fixæ ſub ipsâ orbitâ vel propè eam reſident.], 194, 195.
    - for cometary tails [pro caudis cometicis.], 537.
    - for distinguishing the apparent motion from the true, when a fixed star lies beneath the orbit itself or near it [pro diſtinguendo motu viſo à vero, Fixâ ſub ipsâ, vel propè orbitam exiſtente.], 179, 180.
    - for the headings of the prosthaphaereses, divided into 2 classes [pro proſthaphæreſium titulis in 2 claſſes diviſis.], 231.
    - for seeing a very long tail [pro videndâ caudâ longiſſimâ.], 527.
    - by whose help the properties of the prosthaphaereses of the first as well as of the second inclination are known at once [quorum ope affectiones proſthaph. tam primæ, quàm ſecundæ inclinat. illicò cognoſcuntur.], 194.
    - by whose aid it is safely known whether there is parallax in the observations [quorum beneficio tutò cognoſcitur, num obſervationibus parallaxis inſit.], 226, 227,293.
- The use of the axioms for parallaxes [Axiomatum pro parallaxibus uſus.], 228.

B.

- Description of the bearded comet [Barbati Cometæ deſcriptio.], 443.
- Basirius's observation of the comet of 1652, made at Aleppo [Baſirii Cometæ 1652 obſervatio Alepi habita.], 325.
- Two comets seen together at the same time [Bini Cometæ eodem tempore ſimul conſpecti.], 512, 798, 812, 815, 823, 824[[,/;]] 825, 830, 835, 836, 838, 842.

- Blancanus's opinion on the tails of comets [Blancani de Cometarum caudis ſententia.], 470.
- The size of the arms of Saturn [Brachiorum Saturni magnitudo.], 394.
- Brahe's opinion on the tails of comets [Brahæi de Cometarum caudis ſententia.], 470.
    - opinion on the deviation of the tails [de deviatione caudarum ſententia.], 486.
    - opinion on the direction of the tails [de directione caudarum ſententia.], 462.
    - notes on the new star that arose in Cassiopeia [de novâ Stellâ in Casſiopeâ exortâ annotationes.], 375.
    - and Cysat's: method of deducing parallaxes [& Cyſati parallaxes deducendi ratio.], 285.
    - sizes of the orbs of the planets [magnitudines orbium Planetarum.], 714.
    - his method shows only probable parallaxes [methodus, probabiles tantùm parallaxes commonſtrat], 288.
    - observation of the comet of 1585 [obſervatio Cometæ 1585.], 865.
    - observation of the comet of 1590 [obſervatio Cometæ 1590.], 868.
    - a most exquisite observation of the comet of 1577 [obſervatio exquiſitiſſima Cometæ 1577.], 857.
- Brahe took pains over parallaxes more carefully than the rest [Brahæus præ cæteris ſollicitè parallaxibus dedit operam.], 138.
- Boulliau's judgment on Aristotle's books written on the heavens [Bullialdi de Libris Ariſtotelicis de cœlo ſcriptis judicium.], 320.
- Boulliau's letter to the author about a certain physician who rejects observations altogether, so as not to be disturbed in his opinion [Bullialdi Epiſtola ad Auctorem de quodam Medico, qui obſervationes prorſus reſpuit, ne in opinione ſuâ turbaretur.], 328.
- Boulliau's letter written to the author on vapours and lunar mists [Bullialdi literæ ad Auctorem ſcriptæ de Vaporibus & Nebulis lunaribus.], 367.

C.

- A different method of calculation makes those who compute more secure [Calculi Methodus diverſa, ſecuriores reddit computatores.], 167.
    - method of the parallactic calculation [methodus parallactici.], 185.
    - method for finding the length of the cometary shadow of the year 1652 [methodus pro inveniendâ longitudine umbræ cometicæ anni 1652.], 545, 546.
    - analysis of the parallactic calculation, and explanation of the diagram [parallactici analyſis, & Schematis elucidatio.], 182.
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    - absurdities of Regiomontanus's parallactic calculation [parallactici Regiomontani abſurditates.], 297.

    - method for the variation of the cometary tail, and an example [pro variatione caudæ cometicæ methodus, atque exemplum.], 529, 531, 532.
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    - Regiomontanus's procedure for parallaxes [Regiomontani proceſsus parallaxium.], 298.
    - Regiomontanus's method for parallaxes, from which it is known that a parallax is present [Regiomontani pro parallaxibus methodus, ex quâ cognoſcitur, parallaxin ſubeſſe.], 299.
- A calculation for constructing the theory of comets cannot be set down without a diagram [Calculus abſque Schemate pro conſtruendâ Theoriâ cometarum poni non poteſt.], 759.
    - parallactic: why it was always attached whole to any computations whatever [parallacticus cur integer ſemper in quibusvis ſupputationibus annexus fuerit.], 182.
    - parallactic: which one is to be preferred in the comet of 1652 [parallacticus in cometâ 1652 quinam præferendus.], 209.
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    - of the parallax, for December 30 [parallaxeos,pro die 30 Decembr.], 262.
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    - for finding the longitudes and latitudes of the comet of 1652 from its declination and right ascension [pro inveniendis Longitudinibus & Latit. ex declinatione & aſcenſ. rect. cometæ 1652.], 69,70 usque 75.
- Calculation of the length of the cometary tail of 1652 and 1653 [Calculus pro longitudine caudæ cometicæ 1652 & 1653.], 521, 522, 523, 524.
    - for the theory of the comet of 1652 and 1653 [pro Theoriâ cometæ 1652 & 1653.], 598 & ſeq.
    - how it is to be set up, if the hypothesis from tangents must be restored entirely through the motion of the nodes [quâ ratione inſtituendus, ſi hypotheſis ex tangentibus abſolutè per motum Nodorum reſtitui debeat.], 789.
    - the Regiomontanus calculation of parallaxes: with what caution it is to be begun [Regiomontanus parallaxium quâ cautelâ eſt incipiendus.], 297.
- The heads of comets are, towards the end, really much larger than they were at the beginning of the apparition [Capita cometarum ſub finem longè reverà majora, quàm initio apparitionis extitére.], 562.

- Colour and light of the head of the comet of 1661 [Capitis color, & lumen cometæ 1661.], 722.
    - figure and form of the comet of 1661 [figura, & forma cometæ 1661.], 723.
    - cause of the inclination of the cometary head [cometici inclinationis cauſa.], 657.
    - the wholly averted side of the cometary head, when it can come into our view [cometici pars omninò adverſa,quando in conſpectum nobis venire poteſt.], 709.
- Some imagine the head of a comet as transparent like a sphere of glass, but wrongly [Caput cometæ inſtar [[ſ/l]]phæræ vitreæ pellucidum nonnulli, ſed perperam fingunt.], 475.
    - the head of a comet is not entirely spherical but disc-shaped [cometæ non omninò ſphæricum, ſed diſceum eſt.], 475.
    - how the head of a comet inclines itself, and turns with respect to the path [cometæ quomodo ſeſe inclinat, atque reſpectu Trajectoriæ obvertit.], 656,657.
    - it is shown that the head of the comet of 1652 appeared in the middle of the tail, and from then on displayed a pyramid-shaped coma [cometæ 1652, in medio caudæ apparuiſe, atque exinde comam pyramidatam exhibuiſe demonſtratur.], 536.
    - the head of the comet of 1652 was seen beneath the tail [cometæ 1652 ſub cauda conſpectum eſt.], 536.
    - the cometary head: by what means it is enlarged [cometicum quâ ratione augeatur.], 535.
    - the cometary head: what kind of body it is [cometicum quale corpus ſit.], 646.
    - the cometary head: what face it turns to the Sun [cometicum quam faciem Soli obvertat.], 656.
    - the cometary head: how is it moved? [cometicum quomodo movetur ?], 656.
- Cassini, Auzout and the Reverend Father Pardies: how they agree among themselves as to the perigee [Caſſinus, Auzoutius & R. P. Pardies quomodo quà Perigæum inter ſe conveniunt.], 784.
- Cassini's and Auzout's calculation of the comet of 1665: does it come close to the observations? [Caſſini & Auzoutii calculus cometæ 1665,an ad obſervationes accedat ?], 785,786.
- The judgment of Cardanus and Gassendi on astrological matters [Cardani & Gaſſendi de rebus Aſtrologicis judicium.], 428.
- The apparent tail is at its greatest in sextile aspect, and at a distance double with respect to the Sun and the Earth [Cauda apparens in adſpectu ſextili, & intervallo reſpectu Solis & Terræ duplo, eſt maxima.], 527.

- the apparent tail, at its longest, can extend in a certain position as far as 180° [apparens longiſſima, certo in poſitu, ad 180 gradus excurrere poteſt.], 528.
- a comet has no tail unless the solar rays, through the head of the comet, pass beyond that thinner matter adhering to the comet, and are halted there [cometæ datur nulla, niſi ſolares radii per caput cometæ materiam illam cometæ adhærentem tenuiorem tranſcendant, ibidemq́; ſiſtantur.], 481.
- the different direction of a comet's tail: where it arises from [cometæ diverſa directio unde exorta.], 839.
- a comet's tail standing erect in the manner of a lance [cometæ erecta ad modum lanceæ.], 833.
- a comet's tail: when it could reach almost to the Earth itself [cometæ, quando ad ipſam fermè Terram pertingere poſſit.], 460.
- a comet's tail grazing the earth: could it be detected by the inhabitants of the earth? [cometæ terram radens, an ab incolis terræ deprehendi poſſit ?], 540.
- a comet's tail, according to the different constitution of the cometary body, also deflects in different ways from the true track [cometæ, pro diverſa corporis cometici conſtitutione, diverſimodè etiam à vero tramite deflectit.], 485.
- a comet's tail is a trajection of the solar rays [cometæ eſt Trajectio radiorum ſolarium.], 473.
- an astonishing comet's tail [cometæ ſtupenda.], 810.
- the tail of the comet of 1607 was of almost the same light as the head itself [cometæ 1607 ejusdem ferè luminis cum ipſo capite fuit.], 516.
- the tail of the comet of 1618 was observed without a head [cometæ 1618 ſine capite eſt deprehenſa.], 558.
- why the tail of the comet of 1618 was more spread out in the middle than near the head and the end [cometæ 1618 cur in medio magis, quàm circa caput, atq́ue extremitatem fuerit extenſa.], 537,538.
- the apparent length of the tail of the comet of 1652: did it always appear as great as it really was? [cometæ 1652 longitudo apparens, an tanta ſemper apparuerit, quanta reverà extiterit ?], 531.
- the tail of the comet of 1652 never appeared of as great a length as it really had [cometæ 1652 nunquam tantæ longitudinis apparuit, quantæ reverà extitit.], 533.

- The tail of a comet turned towards the Sun is rarely seen [Cauda cometæ à parte Soli obverſa, rarò conſpicitur.], 480.
  - for the Aristotelians, the tail of comets is like a flame [cometarum Ariſtotelicis flammæ inſtar eſt.], 460.
  - the tail of comets appears longest at a certain distance, before the comet moves 90° away from the Sun [cometarum certa in diſtantia apparet longiſſima, priusquam 90 Grad. à Sole digreditur.], 527.

- the tail of comets can to some extent be seen in the shadow of the planets [cometarum in umbrâ Planetarum quadantenus conſpici poteſt.], 553.
- the tail of comets can sometimes be much nearer the Earth than the head itself [cometarum longè quandoque Terræ eſſe poteſt vicinior ipſo capite.], 459.
- the tail of comets: does it vary remarkably when its true length and the comet's distance from the Earth are changed? [cometarum, longitudine verâ & diſtantiâ cometæ à Terrâ immutatâ, mirificè variatur ?], 530.
- the tail of comets sometimes has a nucleus, or marrow [cometarum nonnunquam habet nucleum, ſeu medullam.], 517.
- the longest tail of all comets: how many degrees did it span? [cometarum omnium longiſſima, quot graduum extiterit ?], 519.
- the tail of comets is now longer, now brighter, according to the quality of the head [cometarum pro qualitate capitis, nunc longior, nunc lucidior eſt.], 481.
- the tail of comets varies according to the condition of the intervening air [cometarum pro ratione aêris intermedii variatur.], 330.
- the tail of comets extends now towards this region, now towards that, according to the position of the Sun and the comet [cometarum, pro Solis & Cometæ ſitu nunc hanc, nunc illam plagam versùs protenditur.], 484.
- the tail of comets: how is it seen? [cometarum quomodo conſpicitur ?], ibid.
- the tail of comets: when does it fail? [cometarum quando deficit?], 556.
- the straight tail of comets is entirely extinguished at the opposition of the comet and the Sun [cometarum recta,in oppoſitione Cometæ & Solis planè extinguitur.], 553.
- the cometary tail: when is it seen with a more compressed face? [cometica quando facie conſpicitur compreſſiori ?], 537.

- When the tail is more compressed, the head is enlarged to some extent, but only in appearance [Caudâ compreſſiore datâ, caput quadantenus augetur, ſed apparenter.], 535.
- Why is the tail in comets so rarely seen from either side? [Cauda in cometis cur ab alterutro latere tam rarò videatur ?], 480.
- The immense length of the tail of a certain comet [Caudæ alicujus cometæ immenſa longitudo.], 832.
  - the ratio of the variation of the apparent tail, at the comet's distance from the earth, double with respect to the Sun [apparentis variationis ratio, in diſtantiâ cometæ à terrâ reſpectu Solis dupla.], 526.

- some philosophers refer the production of the tails of comets to occult qualities [cometarum productionem, Philoſophi nonnulli ad occultas referunt qualitates.], 474.
- the appearance of the tail of a comet grazing the Earth [cometæ Terram radentis facies.], 540.
- the author investigated the deviation of the tail of the comet of 1577 [cometæ 1577 deviationem Auctor exploravit.], 487.
- how great the true length of the tail of the comet of 1607 was [cometæ 1607 vera longitudo quanta extiterit.], 534.
- variation of the length of the tail of the comet of 1652 [cometæ 1652 longitudinis variatio.], 524.
- the remarkable conical solidity of the cometary tail of the years 1652 and 1653 [cometicæ anni 1652 & 1653 ſoliditas conica admiranda.], 544.
- the account of the appearance of the cometary tail [cometicæ apparitionis ratio.], 482.
- the true length of the cometary tail: how does it grow? [cometicæ longitudo vera quomodo creſcit ?], 524.
- the tip of the tail and the head of comets: in what position are they equidistant? [cuſpis, & cometarum caput quo in ſitu æquidiſtent.], 538.
- the tip of the tail: when is it nearer the earth than the head itself? [cuſpis quando vicinior terræ eſt ipſo capite.], 538.
- the tip of the tail: how does it move away from the head itself? [cuſpis quomodo ab ipſo capite removeatur.], 538.
- the curvature of the tail varies according to the diversity of the matter accompanying the comet [curvatura,pro diverſitate materiæ cometam concomitantis variatur.], 498.
- Tycho once ascribed the deflection of the cometary tail to Venus [cometicæ deflexionem Veneri olim adſcripſit Tycho.], 486.
- the deviation of the cometary tail: how great is the greatest of all? [cometicæ deviatio omnium maxima quanta ?], 486.
- the deviation of the tail: is it always equal, and how great is it? [deviatio an æqualis ſemper & quanta exiſtat?], 485.
- if the deviation is removed, no obliquity can be induced in the tails [deviatione remotâ, obliquitas caudis induci non poteſt.], 498.
- the diversity of the deviation of the tail is proved by certain examples [deviationis diverſitas exemplis quibusdam probatur.], 486.
- a notable example of the deviation of the tail [deviationis exemplum notabile.], 555.
- the end of the tail: when it is more remote from the earth than the head itself [extremitas, quando remotior à terrâ eſt ipſo capite.], 538.

- Fluctuation of the tail: when it becomes more noticeable and more inconstant [Caudæ fluctuatio,quando reddatur notabilior & inconſtantior.], 513.
    - the end of the tail: when it appears blunter than it really is [extremitas quando appareat obtuſior, quàm re ipsa exiſtat.], 539.
    - the end of the tail: when it appears more remote from the earth than the head itself [extremitas, quando appareat remotior à terra ipſo capite.], 538.
    - the hump of the curved tail: does it always lie in the middle? [incurvatæ gibbus, an in medio perpetuò conſiſtat?], 506.
    - the curving of the tail: towards which region does it proceed? [incurvatio, quam versùs plagam procedat.], 501.
    - the inflection of the tail: does it appear equal at all times in comets? [inflexio, an omni tempore æqualis in cometis appareat ?], 505.
    - the true length of the tail: is it subject to variation? [longitudo vera, utrum variationi obnoxia ?], 541.
    - the apparent length of the tail: how does it vary? [longitudo apparens quomodo variatur?], 524.
    - the length of the tail of the comet of 1607 [longitudo Cometæ 1607.], 519.
    - the true length of the tail: from what cause and in what way is it subject to variation? [longitudo vera, unde & quomodo variationi ſit obnoxia ?], 541.
    - a singular phenomenon of the tail observed by Cornelius Gemma [phænomenon ſingulare à Cornelio Gemmâ obſervatum.], 453.
    - the extension of the tail is not wholly confined to the point opposite the Sun, but more often deviates to the sides [protenſio ad punctum Solis oppoſitum non omninò adſtringitur, ſed ſæpius ad latera deviat.], 497.
    - how great the length of the tails of certain comets was [quorund. cometarum longitudo quanta fuerit.], 608.
    - the variation of the true length of the tail does not match the variation of the apparent length [variatio longitudinis veræ, variationem longitudinis apparentis non æmulatur.], 524.
    - the true length of the tail: why does it vary? [vera longitudo cur varietur ?], 524.
    - the vibration of the tail: in what manner chiefly does it proceed? [vibratio quâ potisſimùm ratione procedat.], 510.
- Remarkable and irregular tails: how, and for what causes, they appear so [Caudæ admirabiles, & irregulares, quâ ratione, & quibus de cauſis ita appareant.], 506.
    - arched tails: what kind of section they represent [arcuatæ, cujus generis ſectionem referant.], 506.

- tails are brighter and more vigorous around the head and at their outflow [circa caput atq́ue eductionem lucidiores, & vegetiores ſunt.], 515.
- tails of comets observed without heads [cometarum absque capitibus obſervatæ.], 558.
- the tails of comets sometimes appear like a serpentine line [cometarum, aliquando lineæ inſtar ſerpentinæ apparent.], 506.
- the tails of comets: do they always deviate towards the same region of the sky? [cometarum, an ad eandem perpetuò cœli plagam devient ?], 486.
- the tails of comets: do they also come into view by day? [cometarum an de die etiam ſub adſpectum cadant?], 540.
- what the tails of comets are for the Aristotelians [cometarum Ariſtotelicis quid ſint.], 460.
- the tails of comets are in the aether together with the bodies themselves [cometarum cum ipſis corporibus ſunt in æthere.], 459.
- the tails of comets: why are they usually darker and weaker than the heads? [cometarum, cur capitibus obſcuriores plerumq́ue & debiliores ſint ?], 514.
- the tails of comets are always curved upwards by refraction [cometarum ex refractione ſemper ſurſum incurvantur.], 494.
- the tails of comets, even the longest of all, vanish in certain places [cometarum, in quibusdam locis, etiam omnium longiſſimæ evaneſcunt.], 526.
- the tails of comets, to whatever region of the aether they incline, nevertheless always tend towards the parts almost opposite the Sun [cometarum in quamcunq́ue vergant ætheris plagam, ſemper tamen in partes Soli ferè oppoſitas tendunt.], 483.
- what the tails of a comet are according to Riccioli and Grimaldi [cometæ juxta Ricciolum & Grimaldum quid ſint.], 474.
- the tails of comets do not have light of their own [cometarum nativâ luce non gaudent.], 475.

- Some tails of comets do indeed always extend towards the point opposite the Sun, but with a certain deviation [Caudæ cometarum nonnullæ ſemper equidem in Solis oppoſitum extenduntur, ſed cum certâ quâdam deviatione.], 484.
  - the tails of comets are now larger, now smaller, according to the extent of the cometary atmosphere [cometarum pro amplitudine atmoſphæræ cometicæ nunc majores, nunc minores exiſtunt.], 541.
  - the tails of comets: in what way they appear [cometarum, quâ ratione appareant.], 474.
  - the tails of comets: in what way they take on some convexity [cometarum, quâ ratione convexitatem aliquam induant.], 496.

    - how, in the author's view, the tails of comets bend straight rays is shown in a figure [cometarum, quâ ratione juxta Auctoris mentem radios rectos incurvent, iconiſmo oſtenditur.], 495.
    - the tails of comets: in what way they are produced [cometarum, quâ ratione procreentur.], 476,477.
- How the tails of comets are always thrown out towards the point opposite the Sun [Caudæ cometarum, quâ ratione ſemper in Solis oppoſitum projiciantur.], 483.
    - why the tails of comets appear sharper at their very end in some comets [cometarum, quare in nonnullis cometis in ipſo fine appareant acutiores.], 482, 483.
    - the tails of comets: when they stretch out fully towards the point opposite the Sun [cometarum, quando in oppoſitum Solis omninò exporriguntur,], 490.
    - the tails of comets: when they gradually begin to widen out from the head and to separate [cometarum quando paullatim à capite incipiunt dilatari, atque ſegregari.], 482.
    - the tails of comets: when they are brighter and longer [cometarum quando ſunt lucidiores, & prolixiores.], 541.
    - how the tails of comets curve upwards towards the north [cometarum quomodo ſurſumSeptentrionem verſùs incurvantur.], 503.
    - the tails of comets stray from their course in longitude as well as in latitude [cometarum, tam ſecundùm longitudinem, quàm latitudinem exorbitant.], 493.
    - the tails of comets hardly ever appear as long as they really are [cometarum vix unquam tantæ proceritatis apparent, quantæ reverà ſunt.], 533.
    - the tails of comets: where they draw their light from, and how they come into view [cometarum unde lumen hauriant, & quâ ratione ſub adſpectum cadant.], 475.
    - more compressed tails: when they appear [compreſſiores, quando appareant.], 482.
- Tails grow and shrink, but without any proportion or law [Caudæ creſcunt, & decreſcunt, ſed absque omni proportione, & lege.], 542.
    - tails tapering to a cone are almost never seen under the greatest angle of vision [in conum faſtigiatæ ferè nunquam ſub angulo viſionis maximo conſpiciuntur.], 537.
    - some tails of comets are so translucent that they do not block the sight of the stars at all [nonnullæ cometarum adeò ſunt translucentes, ut ſtellarum aſpectum minimè denegent.], 516.
    - some tails are brighter near their end than in the rest of their length, and why? [nonnullæ circa extremitatem ſunt reliquâ parte ſplendidiores, & quare ?], 516.

    - tails can curve in any direction [quaqua verſum incurvari poſſunt.], 505.
- How tails are drawn in around the head and have, as it were, a neck [Caudæ, quâ ratione circa caput coarctentur,& quaſi cervicem obtineant.], 482.
    - how tails brighten and grow dim again [quomodo clareſcunt, & rurſus hebeſcunt.], 515.
    - whether the tails of certain comets can be as brilliant and as bright as the heads of the comets themselves [quorundam cometarum, an æque fulgidæ, ac claræ dari poſſint, quàm ipſa cometarum capita.], 516.
- How a tail ending in a point is produced [Cauda in Mucronem terminans, quomodo procreatur.], 482.
    - the longest tail: how it appears at the very conjunction with the Sun [longiſſima, quâ ratione in ipsâ conjunctione Solis appareat.], 528.
    - or the coma of a comet: how it arises [ſeu coma cometæ quomodo ſuboriatur.], 480.
    - a tail of more than 60° [ultra 60 grad.], 836.
- The tail does not come into view on account of the shadow, although Liceti and Cysat hold otherwise [Caudam ob umbram non in conſpectum venire,utut Lycetus & Cyſatus aliter ſtatuant.], 547.
- The way cometary tails, and their different kinds, are produced [Caudarum cometicarum, earumq; diverſarum ſpecierum procreandi ratio.], 469.
    - compression and dilation of the tails: where they arise from [compreſſio, & dilatio unde oriatur.], 508, 509.
    - the curvature of the tails is always greater than their inclination [curvatura, inclinatione ſemper eſt major.], 505.
    - the curvedness of the tails: how it is produced [curvitas, quâ ratione procreetur.], 507.
- The tip of the tails, where it is nearest the earth [Caudarum cuſpis, ubi terræ eſt vicinisſima.], 538.
- Who first of all detected and demonstrated the direction of the tails [Caudarum directionem,quis omnium primus deprehenderit, ac demonſtraverit.], 461.
    - the difference between tails: on what it depends [differentia, à quâ re dependeat.], 438.
    - the deviation of the tails: can it be bound to fixed laws? [deviatio, num ad certas adſtringi poſſit leges ?], 489.
    - the widening of the tails: how far it extends [dilatatio, quousque ſe extendat.], 513.
    - the appearance of the tails varies remarkably [facies mirificè variatur.], 508.

- The curving of the tails is not always accounted for by straight rays [Caudarum incurvatio non ſemper per rectos ſalvatur radios.], 496.
    - the greatest curving of all, according to the author: how great is it? [incurvatio omnium maxima, juxta Auctorem, quanta ?], 505.
    - the apparent length of the tails differs greatly from the true length [longitudo apparens, differt admodùm à verâ.], 519.
    - the length and breadth of the tails [longitudo, & latitudo.], 518.
    - the true length of the tails is subject to remarkable changes [longitudo vera miris obnoxia eſt vicisſitudinibus.], 542.
- The matter of the tails, from which the tails are produced: where it lies hidden [Caudarum materia, ubinam lateat, ex quâ caudæ procreantur.], 481.
    - how the nucleus of the tails will be produced is illustrated by a diagram [nucleus, quâ ratione producetur, Schemate illuſtratur.], 517, 518.
    - the nucleus of the tails: when does it appear? [nucleus, quando apparet ?], 518.
- The tail has no kinship with shadows, nor can it have any [Caudam nullam habere, nec habere poſſe cum umbris cognationem.], 547, 548.
- The phenomena of the tails are accounted for more successfully by disc-shaped bodies than by spheres of glass [Caudarum phænomena felicius per corpora ſalvantur diſcea, quàm per ſphæras vitreas.], 475.
    - the extensions of the tails seem to deviate according to the latitude of each comet [porrectiones pro cujusvis cometæ latitudine deviare videntur.], 490.
- A sudden change in the tails as regards their light: from what causes does it happen? [Caudarum, quoad lumen ſubitanea mutatio, quibus de cauſis accidat ?], 508, 509.
- The swelling of the tails: where does it come from? [Caudarum tumor unde ?], 508.
    - where the various kinds and the unlike shapes of the tails arise from [variæ ſpecies,diſſimilesq́; figuræ unde oriantur.], 482.
    - the vibrations and flickerings of the tails: how are they set off? [vibrationes & micationes quâ ratione excitentur ?], 510, 512.
    - the vibrations, fluctuations and jerks of the tails are not always the same [vibrationes, fluctuationes & ſubſultationes non ſemper ſunt eædem.], 512.
- It is proved by examples that the tails of comets have been deflected from a straight line [Caudas cometarum à recta linea deflexiſſe, exemplis probatur.], 484.
    - Apian once held that the tails of comets take their origin from the Sun alone [cometarum à Sole unicè ortum ſuum trahere, Appianus olim exiſtimavit.], 461.

    - some authors hold that the tails of comets do not point in an exactly straight line away from the Sun, but with a certain inclination and declination [cometarum non in directum omninò à Sole, ſed cum certâ quadam inclinatione, & declinatione vergere, Auctorum nonnulli ſtatuunt.], 462.
    - it is proved by examples that the tails of comets have been now longer, now shorter [cometarum nunc longiores, nunc breviores extitisſe, exemplis probatur.], 547.
    - it is more likely that the tails are shorter at the beginning [initiò esſe breviores, veroſimilius eſt.], 542.
    - some hold that the tails are longest at the beginning [nonnulli initiò esſe longisſimas ſtatuunt.], 542.
    - it is proved by the calculation of the comet of 1652 that the tails in no way keep the same lengths all the way from beginning to end [nullâ ratione ab initio ad finem usque, easdem ſemper ſervare longitudines, calculo Cometæ 1652 probatur.], 542.
- The causes and effects of many sublunary things are unknown [Causſæ & effectus multarum rerum ſublunarium ignorantur.], 393.
- To uncover the secondary operating cause in comets is not so slight a matter [Causſam operantem ſecundam in cometis detegere, non res eſt adeò leviuſcula.], 392.
- To give physical causes in the matter of comets is an arduous task [Cauſas in cometarum negotio reddere phyſicas [[,/;]] arduum.], 353.
- Is the proportion of speed always the same in all comets? [Celeritatis proportio, an in omnibus cometis ſemper ſit eadem ?], 689.
- Everything extended possesses a centre of gravity [Centro gravitatis omne expanſum gaudet.], 420.
- The Sun is the centre of the planets [Centrum Planetarum eſt Sol.], 385.
- That thinner exhalations exist around comets is highly probable [Circa cometas exſpirationes dari tenuiores, valdè probabile.], 482.
- What points are to be noted concerning the matter of parallaxes? [Circa parallaxium negotium quænā ſunt notanda?], 167.
- A thing is raised and moved more easily or more quickly by larger circles than by smaller ones [Circulis majoribus facilius citiusve quid attollitur & movetur, quàm minoribus.], 583.
- The parallactic circle at a distance of the comet of 10 semidiameters of the Earth: how large was it? [Circulus parallacticus in diſtantiâ cometæ 10 Semid. Terrr. quantus extitit ?] [recte: Terr.], 161.
    - the parallactic circle, if the comet had been below the lunar orb: how large? [parallacticus ſi cometa ſub orbe extitisſet lunari, quantus ?], 162.
- The size of the Circumjovials [Circumjovialium magnitudo.], 394.
- How Aristotle explains the motion and power of the tiller [Clavi commotionem atque potentiam, quomodo Ariſtoteles explicat.], 577.

    - how the working of the tiller is explained by the power of the axle in the wheel and axle [operatio per potentiam axis in peritrochio quomodo declaratur.], 582.
- The longer the tiller, the easier the steering [Clavis quò eſt longior, eò levior eſt directio.], 584.
- Aristotle long ago attempted to explain the force of the tiller and its powers [Clavi vim ejusq́; virtutes exponere, jam Ariſtoteles olim tentavit.], 577.
- The matter of the heavens and of the earth is one and the same [Cœli & terræ materia una eademq́; eſt.], 355.
- The matter of the heavens is alterable [Cœli materia eſt alterabilis.], 363.
- The heavens declare the glory of God [Cœli enarrant DEI gloriam.], 704.
- There is generation and corruption in the heavens [Cœlo ineſt generatio & corruptio.], 354.
- What is the origin of our thoughts? [Cogitationum noſtrar. principium quodnam eſt ?], 354.
- It cannot be concluded that comets necessarily arise at the time of the great conjunctions [Conjunctionum magnarum tempore cometas neceſſariò exoriri, concludi non poteſt.], 427.
- At the time of the great conjunctions comets are produced more readily [Conjunctionum magnarum tempore cometæ producuntur procliviùs.], 427.
- The colour of the tails mostly imitates the colour of the head [Color caudarum,capitis ut plurimùm colorem æmulatur.], 514.
- The diversity of the colour of comets [Coloris cometarum diverſitas.], 330, 331.
- How can the coma of a comet be seen like a peacock? [Coma cometæ quomodo inſtar Pavonis conſpici poteſt ?], 537.
- A comet taking its course from the east towards Aquilo [Cometa ab oriente in Aquilonem curſum inſtituens.], 828.
    - appeared without a beard [absq́ue barbâ apparuit.], 444.
    - without any hairs [absq́ue ullis crinibus.], 866.
- The Acontias comet [Cometa Acontias.], 804, 840.
    - shining to the point of wonder [ad admirationem fulgidus.], 827.
- A comet of wonderful brightness and size [Cometa admirandæ claritatis, atq́ue magnitudinis.], 799, 819, 827.
    - of wonderful speed, when at the same time it appears to travel a winding course [admirandæ velocitatis, quando iter ſimul flexuoſum peragere appareat.], 641.
    - projected its tail to about 90° [ad 90 circ. grad. caudam projecit.], 832.
    - equal to half the Moon [æqualis Lunæ dimidio.], 329.
    - an aerial comet: if it were visible to us for six months, how much distance would it cover in one day? [aêreus ſi per ſex menſes nobis esſet conſpicuus, quantum itineris ſpatium uno die conficeret?], 715.

    - an aerial comet could not have formed a straight line with two stars of Perseus at Paris and at Danzig at the same time [aêreus Pariſiis & Dantiſci rectam ſimul cum binis Perſei Stellis lineam conſtituere haud potuiſſet.], 154.
    - it can sometimes pass through the aether and the air together [ætherem ſimul aêremq́; nonnunquam trajicere poteſt.], 319.
    - the equinoctial comet, whose tail stretched over almost a third part of the heavens [æquinoctialis, cujus cauda cometæ ad tertiam ferè cœli partem protenſa fuit.], 797.
- How many miles does a comet cover in one minute? [Cometa quot milliaria uno ſcrupulo primo conficit ?], 706.
    - one comet is sometimes faster than another: by how many semidiameters of the Earth [alius alio, quot Semid. Terræ nonnunquam eſt velocior.], 701.
    - one comet is more remote than another [alius alio eſt remotior.], 436.
    - if one were to strike another, and either of them were to go off into different parts after the collision, how would those parts move? [alius alium ſi allideret, atq́ue alteruter ex alliſione in diverſas abiret partes, quâ ratione partes iſtæ moverentur ?], 653.
- Does a comet constantly keep the same curvature of the tail that it presents at the beginning of its apparition? [Cometa, an eandem ſemper caudæ incurvationem conſtanter retineat, quàm initiò apparitionis offert ?], 507.
- The most blazing comet [Cometa ardentiſſimus.], 833.
- A comet deflects somewhat from its straight track, away from the Sun [Cometa à recto tramite nonnihil à Sole deflectit.], 641.
    - on first leaving its atmosphere, it is almost never detected by us [atmoſphæram ſuam primùm exiens, nunquam ferè à nobis deprehenditur.], 681.
- The bearded comet [Cometa barbatus.], 825.
    - bearded, like a sword [barbatus gladio ſimilis.], 830.
    - forked: how it is represented [bifurcatus, quo pacto repræſentetur.], 483.
- Two comets seen in one year [Cometæ bini uno anno conſpecti.], 812.
- A northern comet, visible for six months [Cometa borealis, per ſex menſes conſpicuus.], 825.
    - of very short duration [breviſſimæ durationis.], 799, 802.
    - with a small head but a long tail [capite parvo, ſed caudâ prolixâ.], 841.
    - with a twin tail, thrown out in different directions [cauda gemina & diverſim projecta.], 836.
- A comet whose tail occupied almost a quarter of the heavens [Cometa, cauda ſua quartam ferè cœli partem occupans.], 798.
- The ceratius, or horned, comet [Cometa ceratius, ſeu cornutus.], 440.

    - it can obscure the Sun at a certain time [certo tempore Solem obſcurare poteſt.], 540.
    - moving near the ecliptic, it inclines its tail very little [circa Eclipticam verſans parùm admodùm caudam inclinat.], 491.
- A comet sometimes becomes retrograde around the opposition of the Sun [Cometa circa oppoſitionem Solis nonnunquam fit retrogradus.], 640.
    - it is fastest of all around the perpendicular from the Sun [circa perpendiculum ex Sole omnium eſt velociſſimus.], 760.
    - moving around the Sun, it mostly receives the greatest increases [circa Solem verſans maxima plerumque incrementa haurit.], 385.
    - appeared like a column for three continuous months [columnæ inſtar, tribus continuis menſibus apparuit.], 812.
    - bearing the appearance of a cone, seen when the Sun was eclipsed [coni ſpeciem gerens,Sole deficiente conſpectus.], 808.
- The cone-shaped comet [Cometa coniformis.], 450.
- A comet fiery in colour and in tail [Cometa colore, & caudâ igneâ.], 796, 818, 848, 850.
    - blood-red in colour [colore ſanguineo.], 843.
    - with various colours and an oblong tail [coloribus variis, caudâq; oblongâ.], 843.
- A comet, when it is not more remote from the earth than the Sun, projects a longer tail the nearer it is to the Sun [Cometa cùm non remotior à terrâ exiſtit Sole, eò longiorem, quò Soli eſt propior, projicit caudam.], 525.
    - when it passes straight across, it is always faster [cùm rectà trajicit, ſemper eſt velocior.], 678.
- Why is a comet slower in its course at the beginning? [Cometa, cur initiò quoad curſum eſt tardior ?], 676.
- A comet even the fastest in its course: how much space would it traverse in a whole year? [Cometa, curſu etiam velociſſimus, quantum ſpatium integro anno emetiatur.], 714.
- There can be a comet that traverses 16 signs of the zodiac in the space of 50 days [Cometa dari poteſt, qui 50 dierum ſpatio 16 Zodiani ſigna emetiatur.], 633.
    - there can be one that crosses 12 signs in the space of seven months, with an irregular apparent motion [dari poteſt, qui ſeptem Menſium ſpatio 12 ſigna, motu apparenti irregulari trajicit.], 633.
- A comet appeared during an eclipse of the Moon [Cometa, deficiente Lunâ, apparuit.], 809.
- How a comet can appear surrounded as if by a very dense cloud, and at the same time pyramidal [Cometa denſiſſimâ quaſi nube circumdatus, ac pyramidatus ſimul, quomodo apparere poſſit.], 535.
- The disc-shaped comet [Cometa diſceus.], 439.

    - until it reached from the Sun to Saturn, how long an interval of time would be required? [donec à Sole ad Saturnum perveniret, quantum temporis interſtitium requiratur ?], 714.
    - running through 12 signs of the heavens in the space of one month [12 cœli ſigna unius menſis ſpatio percurrens.], 794.
    - sword-shaped, visible for a whole year [Enſiformis integro anno conſpicuus.], 804.
    - like a fiery sword [Enſi igneo ſimilis.], 446.
    - presenting the form of a sword with a tapering point, otherwise the Xiphius comet [enſis faſtigiato mucrone formam referens, aliàs Xiphius Cometa.], 801.
- The horse comet [Cometa Equinus.], 440.
    - of unusual size and shape [& magnitudinis, & formæ inſolitæ.], 842.
- A comet and an eclipse of the Sun occurred together [Cometa, & Solis Ecclipſis unà accidit.], 841.
- A comet of small size [Cometa exiguæ quantitatis.], 834.
    - because of the inclination of its disc, it cannot proceed entirely in a straight line [ex inclinatione diſci, in directum omninò progredi haud poteſt.], 667.
- If a comet were in the air, how great the parallax of different horizons would have been [Cometâ exiſtente in aêre, quanta diverſorum Horizontum parallaxis fuisſet.], 154.
- A comet in the form of a two-edged and dreadful sword [Cometa gladii ancipitis, & horrendi formâ.], 807.
- A comet presenting the form of a sword and a dagger [Cometa gladii, & pugionis formam referens.], 445, 446, 812, 853.
- The spear-shaped comet [Cometa Haſtiformis.], 448.
    - no smaller than the Moon [haud minor Lunâ.], 819.
    - the comet of Jerusalem: was it a portent, or a genuine comet? [Hieroſolymitanus, an oſtentum, an verò genuinus Cometa fuerit ?], 712.
- The comet Hircus [Cometa Hircus.], 440, 799.
    - hairy: how and when it acquires a beard [hirſutus quomodo & quando barbam acquirat.], 526.
    - dreadful, throwing out flames [horribilis, flammas jactitans.], 818, 846.
    - of dreadful size [horrendæ magnitudinis.], 801, 818.
    - dreadful, very bright, and having a long tail [horrendus,clariſsimus,longamq́; habens caudam.], 832, 833.
    - presenting the figure of a beam [figuram Trabis referens.], 449,822.
    - presenting the form of a dragon [formam Draconis referens.], 849.
    - with a funereal and oblong tail [funebri oblongâq́; caudâ.], 550.
    - girdled by a dark cloud [fuſcâ nube cinctus.], 810,811.

    - presenting the form of a javelin [jaculi formam repræſentans.], 445, 804.
    - none is generated in the air [in aêre generatur nullus.], 319.
- A comet in the air can by no means be of perpetual apparition [Cometa in aêre perpetuæ apparitionis fieri nullâ ratione poteſt.], 153.
    - persisting in the air: how long it would last [in aêre perſiſtens, quantæ foret durationis.], 715.
    - at a distance of 20 miles from the Earth, it is seen retrograde, stationary and direct within the space of a few hours, though in a confused order [in diſtantiâ 20 à Terr. milliar. aliquot horarum ſpatio retrograd., ſtation. & directus conſpicitur, confuſo tamen ordine.], 140.
    - in the elements, according to Aristotle and Liceti, it never moves along a great circle [in Elementis nunquam ex mente Ariſtotelis & Lyceti per circulum fertur maximum.], 132.
    - in the form of a lance [in formâ lanceæ.], 810.
    - observed with fiery and large horns [igneis cornubus, & grandibus obſervatus.], 444.
    - like a fiery sword [igneo enſi ſimilis.], 844.
- The fiery comet [Cometa igneus.], 795, 821, 837.
    - of immense size, shining for three months [immenſæ magnitudinis, per tres menſes fulgens.], 798, 801, 811, 827, 832, 834.
    - huge, in the figure of a burning torch [ingens, figurâ facis ardentis.], 842.
    - huge, of the size of a great beam [ingens, magnitudine magnæ Trabis.], 796,814,840.
- A huge comet, with a lurid, funereal and oblong tail [Cometa ingens, luridâ & funebri oblongâq; caudâ.], 833 & 834.
    - huge, visible for 75 days [ingens, per 75 dies conſpicuus.], 796.
    - like a rhomphaea [inſtar rompheæ.], 447, 835, 847.
    - very short at first, it grew in a wonderful way [initiò admodùm brevis, mirum in modum crevit.], 838.
    - of unusual size [inſolitæ magnitudinis.], 824.
    - like a scimitar [inſtar acinacis.], 447, 820.
    - curved like a horn [inſtar cornu incurvatus.], 795.
    - shone like an ostrich feather [inſtar pennæ Struthionis affulſit.], 444.
    - in the highest region of the air it becomes retrograde and stationary twice in the same night [in ſupremâ aêris regione bis in eâdem nocte fit retrogradus, & ſtationarius.], 150.
    - in the highest region of the air it varies its longitudes and latitudes by up to 40° in a very short interval of time [in ſupremâ aêris regione breviſſimo temporis intervall[[o/u]] longitudines & latit. ad 40° variat.], 150.
- The lamp-shaped comet [Cometa Lampadiformis.], 440.

    - although the transparent medium clinging behind the comet is of differing density, it can nevertheless sometimes push the coma out in a straight line [licet diaphanum poſt cometam hærens diverſæ ſit denſitatis; nihilominùs tamen in directum nonnunquam protrudere comam poteſt.], 500.
    - although it may cross 150 semidiameters of the Earth daily, it still cannot by any means pass through even the system of the planets in a whole year [licet quotidiè 150 Semid. Terræ transeat, neutiquam tamen ne ſyſtema quidem Planetarum, integro anno, permeare poteſt.], 713.
- A comet, although the trace of its path does not cut the annual orbit, nevertheless not rarely passes below the intersections [Cometa, licet veſtigium trajectorium non ſecet orbem annuum, nihilominùs non rarò infra ſectiones incedit.], 642.
- A long-lived comet: could it in its course exceed the whole system of the planets, indeed the whole machine of the world? [Cometa longævus, anne curſu ſuo totum ſyſtema Planetarum, imò totam mundi machinam excedere posſit ?], 712.
- A comet seen with long and flaming hairs [Cometa longis & flammineis crinibus viſus.], 814, 819.
    - with a very long tail [longisſimâ caudâ.], 826.
    - wonderful in light and appearance [luce & ſpecie mirabilis.], 814.
    - very bright, larger than Venus [lucidisſimus, major Venere.], 806, 842.
    - bright, shining for 25 days always at the same hour [lucidus, 25 dies eâdem ſemper horâ ſplendens.], 821.
    - with a dull light like the Moon [lumine obtuſo inſtar Lunæ.], 813.
    - like the half Moon [lunæ dichotomæ ſimilis.], 443, 844, 851.
    - resembling the nature of the Moon, and running through the whole zodiac within a short space [lunæ naturam referens, citraq́; breve ſpatium totum ſigniferum percurrens.], 843, 844.
    - equal to the full Moon [lunæ plenæ æqualis.], 820.
    - eclipsing the Moon [lunam eclipſans.], 447.
- A comet almost like the Sun in size and brightness [Cometa magnitudine, atque claritate Soli ferè ſimilis.], 330,799.
    - visible in the morning and in the evening [matutino,& veſpertino tempore conſpicuus.], 811.
    - a morning comet that became an evening one [matutinus, veſpertinus factus.], 846.
    - visible for six months [menſes ſex conſpicuus.], 804, 805, 822, 835.
    - southern, presenting the form of a sword [meridionalis, enſis formam referens.], 820.
    - of wonderful size and tail [mirâ magnitudine & caudâ.], 809, 817, 821, 828.

    - monstrous, dreadful and marvellous [monſtroſus, horrendus, ac mirificus.], 844, 845.
- The comet of Nicephorus consisted of various bodies [Cometa Nicephori ex variis conſtitit corporibus.], 653.
- The black comet [Cometa niger.], 822.
    - it is not aerial on that account when it is lower than the Moon [non ideò eſt aêreus, quando lunâ eſt inferior.], 447.
    - it suffers a total eclipse only from the shadow of the Earth or of the Moon [non niſi ab umbrâ Terræ, vel Lunæ totale patitur deliquium.], 552.
    - notable, glowing red from evening until dawn [notabilis, à veſperâ ad auroram usque rutilans.], 83.
- A comet seen to shine like the new Moon [Cometa, novæ ad inſtar lunæ, lucere conſpectus.], 823.
- No comet comes back, as a sunspot indeed does [Cometa nullus, ut quidem macula ſolaris, fit redux.], 435.
    - dark and pale [obſcurus & pallidus.], 846.
    - dark, pale, with its tail drawn very far upward [obſcurus, pallidus, caudâ longiſſimè ſurſum ductâ.], 848.
    - western, blood-red in colour [occidentalis colore ſanguineo.], 849.
    - passing under the full disc of the Moon, it caused an eclipse [orbem lunæ plenum ſubiens, Eclipſin effecit.], 835.
    - eastern, having a long tail [orientalis, longam caudam habens.], 822.
    - eastern, it afterwards became western [orientalis poſtea occidentalis factus eſt.], 814.
    - presenting a peacock's tail [Pavonis caudam exhibens.], 451, 833.
    - in the judgment of the Peripatetics it can be wandering and erratic, although in truth it is most regular [Peripateticorum judicio alius eſſe poteſt vagabundus & erraticus; cùm tamen reverà ſit regulariſſimus.], 636.
    - of perpetual apparition, and retrograde [perpetuæ apparitionis, & retrogradus.], 848.
- The comet visible all night [Cometa pernox.], 831, 835[[,/;]] 877.
    - visible for 8 months [per 8 Menſes conſpicuus.], 817.
    - shining for four whole months [per quatuor integros menſes ful-gens.], 803, 842.
- The Pitheus comet [Cometa Pitheus.], 439.
    - according as it first leaves the atmosphere at this place or that, it is faster or slower [prout hoc vel illo loco Atmoſphæræ primùm exit, eò velocior, vel ſegnior eſt.], 671.
    - very small, growing wonderfully in the course of time [puſillus, mirum in modum ſucceſſu temporis creſcens.], 800.
- The pyramidal comet [Cometa pyramidatus.], 450.
- The square comet [Cometa quadratus.], 440.

- A comet: at what distance it could not reach the conjunction itself [Cometa, quâ in diſtantiâ ad ipſam conjunctionem pervenire non poſſit.], 527.
- A comet: in what appearance chiefly it is seen, if it grazed the earth [Cometa quâ inprimis ſpecie videtur, terram ſi raderet.], 319.
- How long can a comet linger in its trajectory? [Cometa,quamdiu in trajectoriâ ſuâ commorari poteſt ?], 712.
- When a comet most accelerates its course [Cometa quando curſum magis accelerat.], 682.
    - when and how it is eclipsed by the Sun [quando, & quomodo à Sole eclipſatur.], 710.
    - when it is in the hemisphere of the Sun [quando in Hemiſphærio Solis exiſtit.], 593.
    - when it suffers a total eclipse [quando totale patitur deliquium.], 552.
    - with what speed it moves when it is at its swiftest [quantâ velocitate fertur, quando eſt concitatisſimus.], 677.
    - the farther it sets out from the perpendicular, the smaller the angle of inclination becomes, and its motion is weakened [quantò longiùs à perpendiculo proficiſcitur, tantò angulus inclinationis fit minor, motusq́; debilitatur.], 678.
- A comet: in how long an interval of time it flies through the region of Saturn [Cometa, quanto temporis intervallo regionem Saturni pervolat.], 713.
- A comet: in how long a space of time it would cross the orbit of Mars [Cometa, quanto temporis ſpatio orbem Martis trajiceret.], 713.
    - how much space of the heavens it passes through in each month, given its daily motion of 150 semidiameters of the Earth [quantum cœli ſpatium ſingulis menſibus tranſit, dato ejus motu diurno 150 Semid. Terræ.], 713.
- A comet: how much space it crosses in each month according to Tycho [Cometa, quantum ſpatium ſingulis menſibus juxta Tychonem trajicit.], 714.
    - by what means and at what time it would be darkened by the shadow of a planet or of the Earth [quâ ratione, & quo tempore ab umbrâ Planetæ, vel Terræ obſcuraretur.], 551.
    - by what means it is increased in bulk [quâ ratione mole augeatur.], 649.
    - by what means it can be seen for a whole year [quâ ratione per integrum annum conſpici poſſit.], 641.
    - by what means it can overshadow or obscure a planet [quâ ratione Planetam inumbrare, vel offuſcare poſſit.], 550.
    - by what means it can bring on dreadful darkness even for several days [quâ ratione tenebras per aliquot etiam dies inducere poſſit horrendas.], 540.

- A comet: by what means it can be seen to be motionless as regards its proper motion, and to move only with the daily motion [Cometa, quâ ratione videri posſit, quà motum proprium immotus, & nonniſi motu diurno moveri.], 637.
    - why in the region of the Sun it is more often seen with a ruddy colour? [quare in regione Solis ſæpiùs rutili conſpiciatur colore ?], 390.
    - as regards speed, none is like another [quà velocitatem alteri nullus eſt ſimilis.], 696.
    - in the Author's view, every comet eventually changes its face [quilibet ex mente Auctoris Faciem tandem immutat.], 773.
    - the more acute or the more obtuse the angle that the Sun's ray makes with the trajectory in comets, the slower or the faster it is [quò angulus radii Solaris in cometis cum trajectoriâ eſt acutior vel obtuſior, eò eſt tardior aut velocior.], 669.
    - that it by no means proceeds in a straight line with uniform motion [quod in lineâ rectâ motu æquabili nullo modo progrediatur.], 673.
    - at what place it is direct, stationary and retrograde [quo loco directus eſt,ſtationarius ac retrogradus.], 640.
    - the more it approaches or recedes from the perpendicular, the more its motion is intensified or slackened [quò magis ad perpendiculum accedit, vel recedit, eò magis motus ejus intenditur, vel remittitur.], 687.
    - how is it thinned out? [quomodo attenuatur ?], 386.
    - how does it acquire a very short beard? [quomodo breviſſimam acquirit barbam ?], 554.
    - how it retains from the atmosphere the force to continue its course [quomodo ex atmoſphærâ vim retineat, curſum ſuum continuandi.], 648.
    - how it can pass from one hemisphere into the other, even though its trajectory does not cut the annual orbit [quomodo ex uno hæmiſphærio in alterum transire poteſt, etiamſi trajectoria ejus orbem non ſecet annuum.], 642.
    - how it moves with a regular motion and nonetheless appears to make a winding path [quomodo motu incedit regulari, & nihilo ſeciùs tortuoſum apparet conficere iter.], 636.
    - how it is born [quomodo naſcitur.], 564.
    - how many semidiameters of the Earth it runs through according to the Author's hypothesis [quot Semid. Terr. ſecundùm Auctoris hypotheſin percurrit.], 713.
- How a comet can pass through the whole zodiac in the space of 7 months [Cometa quomodo 7 Menſ. ſpatio totum Zodiacum permeare posſit.], 641.

    - the nearer it is to the Sun, it is not always the faster for that [quò propior Soli, non ſemper eò velocior exiſtit.], 693.
    - the nearer it is to the Sun, by a fixed law, the faster it is [quò Soli eſt propior certâ lege, eò eſt velocior.], 673.
    - how many miles it covers in a single minute [quot milliaria unico minuto primo conficit.], 702.
    - seen for 3 months, penetrating the heavens with its rays [radiis ſuis cœlum penetrans per 3 Menſes viſus.], 813.
    - it is rarely eclipsed totally [rarò totaliter deficit.], 710.
    - a recent comet: by what means it leaves the atmosphere [recens quâ ratione Atmoſphæram exit.], 672.
    - retrograde [retrogradus.], 815, 819, 823, 826.
    - Saturnine [Saturninus.], 844.
    - northern, scarcely yielding to Venus in brightness [ſeptentrionalis, claritate vix Veneri cedens.], 807.
    - in the space of six months it also crossed six signs of the zodiac [ſex menſium ſpatio, ſex quoque Zodiaci ſigna trajecit.], 803.
    - if it existed in the air, it would scarcely be visible for a day [ſi in aêre daretur,vix per diem conſpicuus eſſet.], 715.
    - singular, with coma and ray raised upward and the head hanging downward [ſingularis, coma &radio ſurſum erectis, capite deorſum pendente.], 832.
- A comet, if it covered 150 semidiameters of the Earth daily: would it fly through all the orbs of the planets and of the fixed stars in the space of 6 months? [Cometa ſi quotidiè 150 Sem. Terr. conficiat, anne 6 Menſium ſpatio Planetarum orbes omnes Fixarumq; pervolaret ?], 713.
    - if it crossed straight toward the Sun or away from the Sun, there would be no variation in the inclination of the disc, but it would proceed entirely straight on with uniform motion [ſi rectà ad Solem, vel à Sole trajiceret, nulla inclinationis diſci variatio daretur, ſed in directum omninò, motu æquabili progrederetur.], 686.
    - whether it is above or below the intersections, it can nevertheless be retrograde, against Kepler's opinion [ſive ſupra, ſive infra ſectiones ſit, retrogradus tamen eſſe poteſt contra Keppleri opinionem.], 642.
    - it was almost brighter than the Sun, and its tail occupied a quarter of the heavens [Sole clarior penè erat,& cauda ejus quartam cœli partem occupabat.], 449.
    - almost brighter than the Sun, presenting a tail of about 90° [Sole ferè lucidior, caudam 90 circ. graduum referens.], 800.
    - seen preceding the Sun in the morning and following it in the evening [Solem manè præcedens & veſperi ſubſequens viſus.], 813.
- A comet more wonderful than usual, shining like a beam for 4 months [Cometa ſolitò mirabilior, per 4 Menſes inſtar trabis fulgens.], 819.
- A comet redder than usual [Cometa ſolitò rutilantior.], 816, 817.

    - splendid, and presenting the appearance of a sword [ſplendidus,ac Enſis ſpeciem referens.], 808.
- That four comets were seen opposite one another, turning their tails toward the four quarters of the world [Cometas quatuor ſibi invicem oppoſitos viſos eſſe, caudas versùs quatuor mūdi plagas vertentes.], 845.
- The somewhat dark comet [Cometa ſubobſcurus.], 820.
    - detected at the time of a solar eclipse [tempore Eclipſeos ſolaris detectus.], 450.
    - at the time of the great conjunctions [tempore magnarum conjunctionum.], 842, 859.
    - with a thin head and a very short coma, it traversed up to 30° in one day [tenui capite,comaq́; admodùm brevi ad 30 Grad. uno die emenſus eſt.], 837 & 838.
    - terrible, which they write was in the orb of Mars [terribilis, quem in orbe Martis extitiſſe ſcribunt.], 829 & 830.
    - terrible, blazing over Constantinople [terribilis ſupra Conſtantinopolin flagrans.], 849.
    - at a distance of 3 semidiameters of the Earth from the Earth: how long it could be seen above the horizon [3 Semid. Terr. à terrâ remotus, quamdiu ſupra Horizontem conſpici poſſit.], 159.
    - three times larger than Jupiter [triplo major Jove.], 846.
    - three times larger than Venus [triplo major Venere.], 824.
    - with a sad and mournful face [triſti & lugubri vultu.], 854.
    - tube-shaped [Tubiformis.], 445.
    - higher than Venus [Venere altior.], 816.
    - Spit or Pole [Veru ſeu Pertica.], 440,853.
- A comet 20 miles distant from the Earth changes its place from hour to hour [Cometa 20 Mill. à Terr. diſtans, locum in horam mutat.], 146.
    - 20 miles distant from the Earth: how much it grows and diminishes in a given space of time [20 Mill. à terrâ diſtans, quantum certo temporis ſpatio creſcat, & decreſcat.], 146.
    - sometimes deceives the sight [viſum interdum illudit.], 330.
    - it can by no means pass along a straight line [neutiquam in rectâ tranare poteſt lineâ.], 657.
    - however very swift, it can still scarcely cross the whole orb of Mars in the space of six months [utut velociſſimus, vix tamen ſex Menſium ſpatio totum Martis orbem trajicere poteſt.], 713.
    - Xiphias, 812,840.
    - completing a quadrant of the zodiac in the space of 65 days [Zodiaci quadrantem 65 dierum ſpatio abſolvens.], 794.
- The comet of 1472 constantly directed its tail toward the stars of Gemini [Cometa 1472 ad Stellas Geminorum caudam perpetuò direxit.], 460, 608.
    - it was held by very many to be aerial [aêreus à plurimis eſt habitus.], 601.

    - of all the others it was the slowest in its course [aliorum omnium curſu fuit tardisſimus.], 701.
    - did it complete its motion in a trajectory? [an motum ſuum in Trajectoriâ abſolverit ?], 603.
    - it neither had a parallax of 6° nor was it in the vaporous orb of the Earth [nec parallaxin habuit 6°, nec in orbe terræ vaporoſo extitit.], 611, 612, 613.
    - on what day it showed its swiftest motion [quâ die motum exhibuerit velocisſimum.], 606, 607.
    - when it crossed the ecliptic [quando Ecclipticam tranſiverit.], 607.
- The comet of 1472: at how great a distance it was from the Earth [Cometa 1472 quanto intervallo à terrâ fuerit remotus.], 611, 612.
    - in what way it is upheld by the Author [quâ ratione ab Auctore ſuſtinetur.], 611.
    - in what year did it really appear? [quo anno reverà apparuit ?], 604.
    - at what place it travelled 40° in its orbit [quo loco 40° in ſuâ orbitâ peragravit.], 607.
    - in what sense it is said to be near Spica [quo ſenſu Spicæ dicitur propinquus.], 839, 840.
    - in the space of 24 hours it covered 40° along its path [ſpatio 24 horar. 40° in ſuâ ſemitâ peregit.], 603.
    - it could move in its trajectory under a great circle, notwithstanding its apparent disordered and confused motion [ſub circulo in Trajectoriâ moveri potuit maximo, non obſtante motu ejus apparente in ordinato & incompoſito.], 605,606.
    - in one day it crossed from Virgo into Gemini with retrograde motion [uno die ex Virgine in Geminos motu trajecit retrogrado.], 606.
    - in one day it traversed 4 signs of the zodiac in longitude [uno die 4 ſigna Zodiaci quà longitudinem emenſus eſt.], 605.
- How the comet of 1531 set its course [Cometa 1531 curſum ſuum quomodo inſtituerit.], 689.
    - it was in the highest aether [in altisſimo extitit æthere.], 613.
    - it cannot rightly be kept below 2000 semidiameters of the Earth [infra 2000 Semid. Terr. conſervari rectè non poteſt.], 613.
    - with what motion it advanced [quali motu incesſerit.], 613.
    - at what time it appeared [quo tempore apparuerit.], 612.
    - how many semidiameters of the Earth it was distant from the Earth [quot Semid. Terr. à terrâ fuerit remotus.], 613.
    - it is subject to the laws of a trajectory [Trajectoriæ legibus eſt obnoxius.], 614.
- Why does the comet of 1532 seem, as it were, to conflict with a certain theorem and diagram? [Cometa 1532 quare certo Theoremati & Schemati adverſari quaſi videatur ?], 689.

- The comet of 1533 came to be perpetually visible [Cometa 1533 perpetuæ factus eſt apparitionis.], 847.
- The comet of 1556 was visible all night, and moved against the order of the signs [Cometa 1556 pernox extitit, & contra ſignorum ſeriem procesſit.], 850.
    - it traversed six signs [ſex ſigna peragravit.], 850.
    - where it was swifter in its course [ubinam curſu fuit concitatior.], 853.
- The comet of 1569 eventually became stationary [Cometa 1569 ſtationarius tandem eſt factus.], 854, 855.
- The comet of 1577 shot out the most diverse rays toward different parts of the heavens [Cometa 1577 diverſisſimos radios in diverſas cœli partes ejaculatus eſt.], 508.
    - it sometimes appeared with a smaller tail [minori interdum caudâ apparuit.], 453.
    - it utterly rejects circular motion [motum circularem planè reſpuit.], 589.
    - it was not observed by everyone with the same colour and light [non ab omnibus ejusdem coloris & luminis eſt obſervatus.], 331.
    - it rejects all circles, indeed, but not a suitable trajectory [omnes quidem circulos, ſed non convenientem Trajectoriam reſpuit.], 619.
    - it was the first of all to be properly detected and described [omnium primus ritè detectus atq; deſcriptus eſt.], 452.
    - when did it first shine on the Europeans? [quando Europæis primùm illuxit ?], 855.
    - why it was always direct, and carried with a swifter motion from the beginning [quare ſemper directus & motu concitatiori ab exordio latus fuerit.], 617.
    - it advanced under a great circle [ſub circulo incesſit maximo.], 114, 862.
    - it shot out three brighter rays [tres lucidiores radios ejaculatus eſt.], 454.
    - Tycho Brahe tried in vain to establish it by means of circles [Tycho Brahæus per circulos evincere fruſtra tentavit.], 615.
    - at last it became almost stationary [ultimò ſtationarius penè factus.], 617, 856.
- The comet of 1580 had a tail not entirely opposite the Sun [Cometa 1580 caudam non omninò Soli adverſam habuit.], 864.
    - as regards motion and course, it followed the laws of the planets [quoad motum curſumq; Planetarum leges ſequutus eſt.], 865.
    - it became stationary and retrograde [ſtationarius & retrogradus factus eſt.], 864.
- Why the comet of 1585 showed no tail [Cometa 1585 cur nullam oſtendit caudam.], 620.

- By whom the comet of 1590 was observed [Cometa 1590 à quo eſt obſervatus.], 621.
    - it was devoid of all parallax [omnis parallaxeos expers fuit.], 869.
- The comet of 1596 went from direct to stationary [Cometa 1596 ex directo ſtationarius factus eſt.], 870.
    - which signs of the zodiac it crossed [quænam Zodiaci ſigna trajecit.], 870.
- The comet of 1607 was from the beginning, as regards its proper motion, the slowest of almost all comets [Cometa 1607 ab initio quà motum proprium omnium ferè cometarum extitit tardisſimus.], 624.
    - it was continually direct [asſiduè directus extitit.], 623.
    - as Longomontanus asserts, it directed its tail toward the part opposite the Sun [Caudam, asſeverante Longomontano, in partem Soli oppoſitam direxit.], 463.
    - why and when was it nearer to the Earth, and farther from it? [cur, & quando Terræ extiterit propior, & remotior ?], 623.
    - among the others properly observed so far, it was the swiftest [inter reliquos debitè hactenus obſervatos, fuit velocisſimus.], 701.
    - it was a little faster than Mercury [Mercurio paullò extitit celerior.], 704.
    - it was perpetually visible [perpetuæ fuit apparitionis], 871, 872.
    - when it was found to be stationary [quando ſtationarius eſt deprehenſus.], 623.
    - it was observed in the morning and in the evening at once [ſimul manè & veſperi eſt obſervatus.], 622.
    - toward the end it bent its path toward the Sun [ſub finem ſemitam ſuam Solem versùs inflexit.], 623.
- Whether the comet of 1618 also changed its inclination in proportion to its curvature? [Cometa 1618 an pro incurvationis ratione, inclinationem quoque mutaverit ?], 504.
    - toward its end it shone all night [circa exitum totâ nocte fulſit.], 882.
    - it moved continually farther and farther from the Earth [continuò à terrâ magis magisq; eſt elongatus.], 343.
    - why was it more splendid at the beginning, but paler afterwards? [cur principiò ſplendidior extiterit, deinde verò pallidior fuerit ?], 344.
    - why did it turn aside from a straight path toward the end? [cur ſub finem à recto tramite deflexerit ?], 118, 628.
    - it obscured some fixed stars and covered them completely [fixas nonnullas obſcuravit, & penitùs texit.], 516.
    - it had a nucleus, or marrow, in its tail [in caudâ habuit nucleum, ſeu medullam.], 517.
    - it possessed irregular nuclei [nucleos posſedit irregulares.], 350.

- it threw out almost the longest tail of all [omnium ferè longiſſimam projecit caudam.], 519.
- as regards its true proper motion, it was the swiftest of all [quà motum proprium verum omnium extitit velociſſimus.], 629.

- How the comet of 1618 grew [Cometa 1618 quâ ratione creverit.], 343,414.
  - on what day it lost the curvature of its tail [quo die caudæ curvitatem exuit.], 883.
  - on what day did it first appear in Hungary? [quo die in Hungariâ primùm apparuit ?], 873.
  - how it deviated from a great circle [quomodo à circulo maximo deviaverit.], 624.
  - for how many days it was visible [quot diebus fuerit conſpicuus.], 624.
  - it stopped below the orb of Jupiter [ſub Jovis orbe ſubſtitit.], 887.
  - although it is counted among the principal ones, it was nevertheless not observed precisely enough [utut inter præcipuos numeratur, ſatis tamen exquiſitè obſervatus non eſt.], 625.
- The comet of 1647 turned its tail somewhat away from the point opposite the Sun [Cometa 1647 caudam ab oppoſito Solis nonnihil deflexit.], 464.
  - why could it not be seen for longer? [cur diutiùs videri non potuerit ?], 886.
  - it was seen for only a few days [paucis tantummodò diebus conſpectus fuit.], 456.
  - why was it not equally detected by others? [cur non ab aliis æque fuerit deprehenſus ?], 456, 457, 886.
  - where and by whom it was first observed [ubi & à quo primùm ſit obſervatus.], 456.
- The comet of 1652 was an altogether wonderful and unusual portent [Cometa 1652 admirandum prorſus & inſolitum fuit oſtentum.], 330.
  - it was higher than 8600 miles [altior 8600 Mill. extitit.], 161.
  - whether it obscured any planet? [an ullum Planetam obſcuraverit?], 550.
  - by whom it was detected first of all [à quibus omnium primò eſt deprehenſus.], 457.
  - it is subjected to a most rigorous calculation with respect to its motion along the trajectory [Calculo rigidiſſimo ratione motûs Trajectorii ſubjicitur.], 592.
  - it threw out its tail toward the point opposite the Sun, with a certain deviation [Caudam cum quâdam deviatione in Solis oppoſitum projecit.], 464.
  - at a certain time it stood above the horizon for 17 hours [certo tempore per 17 horas ſupra horizontem extitit.], 151.

- toward its end it almost equalled the Sun in size, if its body was spherical [circa exitum, Solis ferè magnitudinem æquavit, corpus ſi fuerit ſphæricum.], 338.
- toward its end it almost surpassed Mars in its distance from the Earth [circa exitum remotione à terrâ Martem penè ſuperavit.], 137.
- toward the end it was carried up as far as Saturn [circa finem ad Saturnum usque evectus eſt.], 317.
- toward the end it turned its route aslant [circa finem iter ſuum obliquavit.], 632.
- it receded continually from the Earth as far as the orb of Jupiter [continuò à terrâ diſcesſit ad Jovis usque orbem.], 888.
- it advanced constantly under a great circle [conſtanter ſub circulo incesſit maximo.], 132.
- at last it lost all its hair [Crines ultimò omnes deperdidit.], 891.
- why on certain days it showed a beard shorter than usual [cur barbam certis diebus oſtenderit ſolitò curtiorem.], 631.
- why it threw out a very long tail [cur caudam projecerit procerisſimam.], 631.
- why did it show a head larger than usual on December 20? [cur die 20 Decembr. caput oſtenderit ſolitò amplius ?], 631.
- why was it paler than the comet of 1618? [cur pallidior extiterit cometâ 1618 ?], 415.
- it had a different size on each day [diverſam ſingulis diebus posſedit magnitudinem.], 336.
- even at its least size it far surpassed the Moon in magnitude [etiam in minimâ quantitate, magnitudine Lunam longè ſuperavit.], 324.
- on the hypothesis it does not come out lower than the parallaxes determine it [ex hypotheſi non humilior evadit, quàm parallaxes eum definiunt.], 632.

- Supposing the comet of 1652 were in the region of the air: how great its parallax would have been between Paris and Danzig [Cometâ 1652 exiſtente in regione aêreâ, quanta inter Pariſios & Dantiſcum ejus fuisſet parallaxis.], 154.
  - at the beginning it was bearded [initiò barbatus extitit.], 458.
  - at the beginning it was very near the Earth [initiò terræ fuit vicinisſimus.], 316.
  - it was in the highest aether [in ſummo extitit æthere.], 136.
  - it is to be counted among the largest [inter maximos eſt recenſendus.], 330.
  - it displayed a mane turned away from the Sun [Jubam exhibuit à Sole averſam.], 464.
  - according to Wendelen it exceeded the Moon in size [juxta Wendelinum magnitudine lunam excesſit.], 889.

- it was much more remote than the Moon, even at its least distance from the Earth [Lunâ multò extitit remotior, etiam in minimâ ejus à terrâ diſtantiâ.], 316.
- it had an unequal but regular motion [Motum habuit inæqualem ſed regularem.], 107.
- at all times it was higher than the Moon [Omni tempore lunâ altior extitit.], 137,140,162,163.

- The comet of 1652: with what tail it was furnished on each day [Cometa 1652 quâ caudâ, ſingulis diebus præditus fuerit.], 458.
  - on what day it reached the orb of Jupiter [quâ die, Jovis attigerit orbem.], 317.
  - with what face it appeared in America [quâ Facie in Americâ apparuerit.], 351.
  - on what day it passed through the region of the Sun [quâ die Solis pervaſerit regionem.], 317.
  - when it crossed the ecliptic [quando Eclipticam tranſiverit.], 888.
  - when it could no longer be seen with the naked eye [quando nudo oculo non ampliùs fuit conſpectus.], 16.
  - how much space of the heavens it traversed [quantum cœli ſpatium eſt emenſus.], 888.
  - with which instruments it was observed [quibus Inſtrumentis fuit obſervatus.], 5.
  - the farther it was removed from the Earth, the more its apparent diameter was diminished [quò magis à terrâ elongatus, eò magis Diameter ejus apparens eſt attenuata.], 346.
  - how it turned its tail aside during the whole time of its duration [quomodo toto durationis tempore caudam deviaverit.], 491.
  - on what day it first shone forth [quo die primùm illuxerit.], 887.
  - at what time it was seen by the Americans [quo tempore ab Americanis fuit conſpectus.], 457.
  - at what time it crossed the ecliptic [quo tempore Eclipticam tranſiverit.], 125.
  - each day it moved away from us and became higher [quotidiè à nobis discesſit & altior factus.], 314,316.
  - how many times it was larger than the Moon, but smaller than the Earth and the Sun [quoties lunâ major; Terrâ verò & Sole minor extiterit.], 336.
  - how long it was observed by the Author [quousque ab Auctore eſt obſervatus.], 16.
  - how long it lasted [quousque duraverit.], 887.
  - if it had not been higher than the Moon, it would likewise have shown a parallax for different horizons [ſi non altior lunâ extitisſet, pariter parallaxin diverſorum Horizontum oſtendisſet.], 163.

    - it stood higher, beyond 2580 miles [ultra 2580 Mill. altiùs extitit.], 158, 159.
    - although it apparently decreased day by day as regards its diameter, in reality it grew in bulk [utut apparenter quoad Diametrum in dies decrevit, reverà tamen mole crevit.], 338.
- The comet of 1661 advanced from Eurus to Zephyrus, on a track almost parallel to the ecliptic and the equator, and retrograde [Cometa 1661 ab Euro, ad Zephyrum, ductu propemodùm Eclipt. & Æquatori parallelo, atq; retrogrado progreſſus eſt.], 742.
    - it could not be seen before February 1 [ante 1 Febr. conſpici haud potuit.], 743.
    - it showed a tail entirely erect [caudam exhibuit planè erectam.], 722.
    - it was sometimes seen deprived of its tail [caudâ quandoq; orbatus eſt conſpectus.], 723,893.
    - in common with all the others, it continually maintained a most regular motion [cum cæteris omnibus regularisſimum continuò exercuit motum.], 743.
    - on March 10 it could be seen neither with the naked eye nor with the armed eye [die 10 Martii nec nudo, nec armato oculo videri potuit.], 724.
- The comet of 1661 was observed on March 28 with a very long tube [Cometa 1661 die 28 Martii Tubo prælongo eſt obſervatus.], 730.
    - although it was by far the swiftest, it still would not have crossed the whole orb of Saturn even in a whole year [etſi fuerit multò rapidisſimus, tamen nec integro anno totum orbem Saturni trajecisſet.], 754.
    - how far it extended its motion along the trajectory in the space of 24 hours [in quantum motum ſuum Trajectorium 24 horarum ſpatio intenderit.], 751.
    - in its trajectory it was faster than the rest [in Trajectoriâ ſuâ [[;/,]]reliquis fuit velocior.], 751.
    - did it run its course within the annual orbit? [intra orbem annuum curſum ſuum duxit ?], 747.
    - it was in the highest aether [in ſummo extitit æthere.], 892.
    - it was born and died within the planetary system, and never left it, although it was extremely swift [in ſyſtemate Planetario natus, denatusq; eſt, nec unquam illud egreſſus, licet fuerit rapidisſimus.], 754.
- The comet of 1661 is rightly counted among the slowest [Cometa 1661 inter tardisſimos meritò numeratur.], 743.
    - in apparent motion it was the slowest, but in true motion the swiftest of the others [motu apparente fuit tardisſimus, ſed motu vero aliorum rapidisſimus.], 752.

- it did not display a perfect roundness [non abſolutam præ ſe ferebat rotunditatem.], 893.
- all those things, whatever they may be, that have been asserted about comets in general are corroborated and confirmed [omnia illa, quæcunque in univerſum de Cometis aſſerta ſunt, corroborantur, ac confirmantur.], 754.
- it showed a different parallax on each day [parallaxin ſingulis diebus retulit diverſam.], 745.
- beyond the rest, it displayed a wonderful apparent orbit [præ reliquis admirandam exhibuit orbitam apparentem.], 720.
- because of its notable northern latitude, it could also have been seen in the evening [propter inſignem Borealem latitudinem, & veſperi videri potuiſſet.], 721.

- The comet of 1661: on what day it first shone forth [Cometa 1661 quâ die primùm illuxerit.], 743.
  - what kind of tail it showed [qualem caudam exhibuerit.], 510.
  - what kind of apparent course it kept [qualem ſervavit curſum apparentem], 724.
  - how long it was observed by the Author [quamdiu ab Auctore eſt obſervatus.], 720,743.
  - how long it remained [quamdiu ſubſtiterit.], 459.
- The comet of 1661: at what distance it was removed from the Earth [Cometa 1661 quanto intervallo à terrâ fuit remot9.], 745.
  - how much more remote than the Moon it was [quantò lunâ fuit remotior.], 745.
  - how much space of the heavens it traversed in its whole duration [quantum cœli ſpatium totâ ſuâ duratione eſt emenſus.], 742,754,894.
  - which orbs of the planets it travelled through [quos Planetarum orbes peragravit.], 745.
  - how many semidiameters of the Earth it crossed in one day [quot Semid. Terræ uno die trajecit], 751.
- The comet of 1661 advanced under a very oblique apparent orbit [Cometa 1661 ſub Orbitâ inceſſit apparenti valdè obliquâ.], 892.
  - where it was retrograde [ubi retrogradus extiterit.], 724.
  - where it was swiftest [Ubi extiterit celerrimus.], 752.
  - it possessed a notable variation of its orbit [Variationem orbitæ inſignem poſſedit.], 743.
  - for the most part it was detected in refraction [utplurimùm in refractione deprehenſus.], 730.
- The comet of 1664 deviated perceptibly from the arc of a great circle [Cometa 1664 ab arcu circuli maximi ſenſibiliter deviavit.], 896.
  - it was observed earlier elsewhere than at Danzig [alibi citiùs quàm Gedani eſt obſervatus.], 897.
  - at the end it was retrograde [in fine retrogradus extitit.], 761.

- at the beginning it stretched its tail toward the west, afterwards toward the east [initiò Caudam Occaſum, poſteà Ortum versùs porrexit.], 895.
- it was in the highest aether [in ſummo extitit æthere.], 758.
- with what tail it was furnished [quâ Caudâ fuerit præditus.], 895.
- which signs of the zodiac it crossed in its retrograde motion [quænam Zodiaci ſigna motu ſuo retrogrado trajecerit], 896.
- with what kind of head, and how large, it shone forth at the beginning [quali & quanto Capite initiò illuxerit.], 894.
- when it was nearest, and when most remote [quando fuit vicinisſimus, & remotisſimus.], 758.
- how far it was removed from the Earth according to the observations [quanto intervallo à Terrâ fuerit elongatus juxta obſervationes.], 758.
- how far it was distant from the Earth according to the tracing of the diagram [quanto ſpatio à Terrâ abſuit ſecundùm Schematis ductum.], 762.
- at what time it was seen by the Author at Danzig [quo tempore ab Auctore Dantiſci fuerit conſpectus.], 894.
- how many semidiameters of the Earth it was distant from the Earth at perigee [quot Semid. Terræ in Perigæo à terrâ diſtiterit.], 758.
- for its whole duration it constantly ran its course outside the great orb [totâ duratione conſtanter extra Orbem magnum curſum ſuum duxit.], 759.

- The comet of 1665 was nearer the Earth at the beginning than at the end [Cometa 1665 ab initio Terræ fuit propior, quàm in fine.], 769.
  - it rose as far as Mars [ad Martem usq; aſcendit.], 900.
  - it was seen deprived of almost all its hair on its forward side [à parte anteriore omni penè capillitio orbatus viſus eſt.], 899.
  - it showed almost the same tail for its whole duration [Caudam totâ duratione penè exhibuit eandem.], 899.
  - in brightness it almost surpassed the stars [Claritate ſtellas ferè ſuperavit.], 898.
  - it is almost diametrically at odds with the comet of 1664 [cum Cometâ 1664 è Diametro ferè pugnat.], 772.
  - it had, as it were, a fissure in its coma [Fisſuram in Comâ quaſi habuit.], 898.
  - in which orb of the planets it moved [in quo Planetarum Orbe degerit], 771.
  - it advanced within the annual orbit, and in the highest aether [intra Orbem annuum, atq; in altisſimo æthere incesſit.], 900.
  - toward which quarter it inclined its tail [quam plagam verſus caudam inclinaverit.], 774.
  - when it came as far as the Sun [quando ad Solem usq; pervenerit.], 900.

- how far it was distant from the Sun, and with what motion it advanced with respect to the Sun [quanto intervallo à Sole abfuerit, & quo motu reſpectu Solis incesſerit.], 772.

- The comet of 1665: how far it was removed from the Earth, both at the beginning and finally [Cometa 1665 quanto ſpatio tam initiò, quàm ultimò âTerrâ fuerit remotus.], 771.
  - at what place the trace of its path intersected the annual orbit [quo loco veſtigium trajectorium Orbem annuum interſecuerit.], 768.
  - how many semidiameters of the Earth it covered in the space of 48 hours, at the beginning and at the end [quot Semid. Terræ initiò & in fine 48 horarum ſpatio abſolverit.], 771.
  - how long it was observed by the Author at Danzig [quousq́; ab Auctore Dantiſc. eſt obſervatus.], 899.
  - how long it put forth its hair [quousq́; crines produxerit.], 899.
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  - with respect to the inclination of its trajectory, it corresponds to the comet of Regiomontanus and Apian [ratione inclinationis trajectoriæ,CometæRegiomontani & Appiani reſpondet.], 768.
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  - the head: in what position it can hide the tail and, as it were, eclipse it [caput,quo in loco caudam abſcondere, & quaſi eclipſare poſſit.], 526.
  - the apparent tail is now larger, now smaller, according to the comet's varying distance from the Earth and the angle of vision, although its true length is always the same [cauda apparens pro variâ diſtantiâ Cometæ à terrâ & angulo viſionis nunc major, nunc minor eſt, licet vera longitudo ſemper ſit eadem.], 526.
  - to ascertain the genuine place of any comet whatever is arduous [cujusvis genuinum Locum explorare, arduum.], 314.
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- although to the naked eye the head seemed, as it were, to decrease, yet in reality, with the help of the telescope, it grew from day to day [caput, utut nudo oculo decreſcere quaſi videbatur; reverà tamen ope Teleſcopii in dies crevit.], 885.
- why the tail was so long on December 7 and 10 [Cauda, cur die 7 & 10Decembri adeò extiterit longa ?], 628.

- The comet of 1618: in what situation its tail could have been seen at 180° [Cometæ 1618 cauda, quo ſitu 180 Grad. videri potuisſet.], 534.
  - the tail, while decreasing, received new increases [cauda decreſcens, nova incrementa accepit.], 884.
  - direction and deflection of the tail [caudæ directio & deflexio.], 877, 878, 879.
  - appearance, colour, light and delineation of the tail [caudæ facies,color, lumen & delineatio.], 455,873, 874.
  - inclination of the tail [caudæ Inclinatio.], 489.504.
  - the striking vibration of the tail [caudæ inſignis vibratio.], 880,879.
  - breadth of the tail [caudæ Latitudo.], 883.
  - length of the tail [caudæ Longitudo.], 455, 624, 878, 879, 880,881, 883, 884.
  - the wonderful extension of the tail [caudæ mira exporrectio.], 880.
  - the notable scintillation and fluctuation of the tail [caudæ notabilis ſcintillatio & fluctuatio.], 883.
  - Snellius too noticed the reciprocation of the tail [caudæ reciprocationem,Snellius quoque animadvertit.], 882.
  - a very notable reciprocation of the tail [caudæ reciprocatio valde notabilis.], 880.
  - variation of the tail [caudæ variatio.], 456.
  - the tail stood in the aether [cauda in æthere extitit.], 884.
  - the tail swelled out towards the south [cauda in Auſtrum extumeſcebat.], 880.
  - the tail inclined obliquely [cauda in obliquum vergebat.], 882.

    - the tail seen straight at its rising, but oblique at the meridian [cauda inOrtu recta,in meridie verò obliqua viſa.], 883.
    - the source of its pale and dim colour [color pallidus & obſcurus unde ?], 344.
- The comet of 1618: its coma gradually grows faint [Cometæ 1618 coma paullatim langueſcit.], 884.
    - of what bodies its body consisted [Corpus ex quibus conſtitit corporibus.], 343.
    - its course beside the heavenly stars [Curſus juxta ſidera cœleſtia.], 877, 878, 879, 882.
    - the curvature vanished [Curvitas evanuit.], 877.
    - the exquisite observations of Cysat [Cyſati exquiſita obſervata.], 341, 456, 882.
    - deviation [Deviatio.], 624, 877, 880.
    - the true and apparent diameter grew from day to day [Diameter vera & apparens de die in diem crevit.], 345, 346, 880.
    - distance from the Earth [Diſtantia à Terrâ.], 321, 343, 628, 880, 884.
    - duration [Duratio.], 878.
    - its appearance detected with the tube by Wendelen [Facies Tubo detecta à Wendelino.], 878, 879.
    - how far the fluctuation spread itself [Fluctuatio quousque ſe dilataverit.], 513.
    - its genuine appearance, engraved on copper [Genuina facies æri inciſa.], 342.
- The comet of 1618: a striking phenomenon of the tail [Cometæ 1618 inſigne caudæ phænomenum.], 456.
    - intersection of the ecliptic [Interſectio Eclipticæ.], 879.
    - its place in the opinion of Wendelen [juxta opinionem Wendelini locus.], 878.
    - its situation according to P. Gassendi [juxta P. Gaſſendum ſitus.], 876.
    - the place at which it crossed the ecliptic [Locus quo Eclipticam transgreſſus eſt.], 877.
    - the place at which it came to rest [Locus quo reſederit.], 873, 874, 880, 881.
    - light [Lumen.], 343, 455, 874, 877.
    - motion [Motus.], 874.
    - why its motion in longitude was swifter at the end [Motus longitudinis in fine cur velocior extiterit?], 627.
- The comet of 1618: why its apparent motion was slower, although its true motion was quite fast [Cometæ 1618 Motus apparens cur tardior, licet verus ſatis velox extiterit ?], 628.
    - motion according to Longomontanus [Motus juxta Longomontanum.], 879.

- the nuclei were seen sparser and more scattered from one another when the body was larger [Nuclei rariores & inter ſe disſipatiores, corpore exiſtente ampliori viſi.], 885.
- the nucleus grew, and was dissolved into different parts [Nucleus crevit, & in partes diverſas disſolutus eſt.], 885.
- the nucleus finally went off into several [Nucleus tandem in plures abiit.], 341, 342, 343.
- Crüger's observation [Obſervatio Crûgeri.], 340.
- Gassendi's observation [obſervatio Gaſſendi.], 876.
- the observation made in Spain [obſervatio in Hiſpaniâ peracta.], 878.
- Kepler's observation [obſervatio Kepleri.], 880.
- the observation of Longomontanus [obſervatio Longomontani.], 879.
- even the more correct observations waver [obſervationes etiam correctiores vacillant.], 625.
- the observation of P. Horatius Crassus, made at Rome [obſervatio P. Horatii Craſſi, Romæ habita.], 881.
- Wendelen's observation [obſervatio Wendelini.], 878.
- parallax [Parallaxis.], 628, 881, 878.
- the parallax decreased gradually [parallaxis ſenſim decrevit.], 884.
- proportion to the Earth and the Moon [Proportio ad Terram & Lunam.], 880.
- proportion of the head to the Earth and the Moon [Proportio capitis ad terram lunamq;.], 884.
- its phenomena are in no way saved by eccentrics [Phænomena per Eccentricos nullâ ratione ſalvantur.], 629.
- theory [Theoria.], 627.
- how the trajectory advanced over the trace [Trajectoria quomodo ſuper veſtigio inceſſerit.], 627.
- the trace moved continually away from the Sun [Veſtigium à Sole continenter discesſit.], 627.

- The comet of 1647: apparition [Cometæ 1647 Apparitio.], 456, 886.
  - size of the head [Capitis quantitas.], 457, 886.
  - direction of the tail; appearance [Caudæ directio, Facies.], 456,464, 886.
  - inclination of the tail [caudæ inclinatio.], 489.
  - length of the tail [caudæ longitudo.], 457.
  - course [Curſus.], 457.
  - the place at which it stood still [Locus quo ſubſtiterit.], 456, 886.
  - brilliance [Splendor.], 457.
- The comet of the year 1652: angle of inclination [Cometæ anni 1652 Angulus inclinationis.], 888.

- the angle of the orbit, with both the ecliptic and the equator, for each day and for their quarters [Angulus Orbitæ, tàm Eclipticæ, quàm Æquatoris, ad dies ſingulos, eorumq́; quadrantes.], 128.
- first apparition [Apparitio prima.], 1.
- the main points of the calculation are set out in tables [Calculi capita Tabul. exhibentur.], 630, 631.
- which parallactic calculation is to be preferred [Calculus parallacticus quinam præferendus.], 209.
- calculation for the digressions [calculus pro digreſſionibus.], 80, 81, 82, 83, 84.
- calculation for finding the longitudes and latitudes from the declination, from the right ascension [calculus pro inveniendis longitudinibus & latitudinibus ex Declinat. ex Aſcenſ. Rect.], 69, 70 to 75.
- calculation for the daily motion, the angle of the orbit, and its intersection [calculus pro motu diurno, angulo Orbitæ, ejusq́; interſectione.], 88, 89, 90 to 104.
- the calculation for the trajectory motion is illustrated with a diagram and lines [calculus pro motu trajectorio Schemate & lineis illuſtratur.], 592.
- colour and size of the head and tail [Capitis caudæq́; color, magnitudo.], 1, 2, 7, 11, 13, 323, 324, 887, 888, 891.
- the astonishing size of the head destroys Aristotelian philosophy [capitis magnitudo admiranda, Philoſophiam deſtruit Ariſtotelicam.], 329.
- why the head was seen larger than usual on December 20 [Caput, cur die 20 Decembr. ſolitò amplius viſum fuerit ?], 631.
- the head consisted of nuclei, or little stars [caput ex nucleis ſive ſtellulis conſtitit.], 328.
- the head decreased from day to day [caput in dies decrevit.], 326.
- the head became rarer and thinner, its matter gradually dispersing [caput rariùs ac tenuiùs eſt redditum, materiâ paullatim disgregatâ.], 890.
- why the tail was always brighter in the evening than in the morning [Cauda,cur clarior ſemper veſpertino tempore extiterit, quàm matutino ?], 327.
- why the tail appeared exceedingly long [cauda, cur procerisſima apparuerit ?], 631.
- deviation of the tail [caudæ deviatio.], 464,466,467,468,469,489,491.
- projection, or direction, of the tail [caudæ projectio ſeu directio.], 7,8,10,14,464,887.

- The comet of 1652: its tail was seen now longer, now shorter [Cometæ 1652 cauda nunc longior, nunc brevior eſt viſa.], 891.

- the tail was always stretched out with some deviation towards the side turned to the sun [cauda ſemper ſub deviatione aliquâ ad partem ſoli obverſam fuit protenſa.], 891.
- conjunction with the bright one of Medusa [Conjunctio cum clarâ Meduſæ.], 3.
- the body truly grew [Corpus reverà crevit.], 891.
- the body possessed various nuclei [corpus diverſos poſſedit nucleos.], 889.
- the body was truly smaller than the body of the Sun [corpus, ſolari corpore reverà minus fuit.], 338.
- what the body was like [corpus quale extitit.], 339.
- course [Curſus.], 2,4, 11,887.
- the genuine delineation of its course [cursûs genuina delineatio.], 130.
- delineation of its first apparition [Delineatio primæ apparitionis.], 6.
- description of the tail [Deſcriptio caudæ.], 891.
- whether the apparent diameter grew in reality, or only by reason of the distance? [Diameter apparens an reverà, an verò ratione intervalli ſolummodò creverit ?], 336.
- the genuine diameter [Diameter genuina.], 332.
- the diameter decreased daily [Diameter quotidiè decrevit.], 347, 889.
- if the diameter had decreased by 100 miles each day, it would already have vanished in the month of December [Diameter, ſi diebus ſingulis 100 Milliar. decreviſſet, Menſ. Decembri jam evanuiſſet.], 348.
- size and variation of the apparent diameter [Diametri apparentis magnitudo, & variatio.], 327.
- the size of the apparent diameter, if the true diameter had always remained the same [Diametri apparentis quantitas, ſi vera ſemper permanſiſſet eadem.], 347.

- The comet of 1652: disappearance [Cometæ 1652 diſparitio.], 16.
  - distance [Diſtantia.], 314,316, 333,888.
  - duration [Duratio.], 887.
  - its genuine likeness, engraved on copper [Effigies genuina æri inciſa.], 327.
  - ephemeris of the true motion, for each day and for their quarters [Ephemeris veri motûs, ad dies ſingulos, eorumq́; quadrantes.], 129, 130.
  - its appearance, detected with the telescope [Facies Teleſcopio detecta.], 326.
  - shape of the head [Figura capitis.], 333.
  - its place, with respect both to the ecliptic and the equator and to its distance from the Sun [Locus, tàm reſpectu Eclipticæ & Æquatoris, quàm diſtantiæ ejus à Sole.], 86.

- its genuine place [Locus genuinus.], 314.
- length of the tail, or beard [Longitudo caudæ, ſive Barbæ.], 1,7, 10.
- the true length of the tail increased continually [longitudo caudæ vera perpetuò eſt aucta.], 891.
- light and colour [Lumen & color.], 2, 7, 11, 13,323,326.
- size and shape [Magnitudo & Figura.], 1, 324,329, 330.
- size of the diameter [Magnitudo Diametri.], 7, 8, 10, 11. 12, 14.
- apparent motion [Motus apparens.], 631.
- continuous motion [Motus continuus.], 108.
- its proper daily motion was not always uniform [Motus diurnus propri9 æqualis ſemper non fuit.], 131.
- its motion was supremely regular [Motus fuit ſummè regularis.], 887.
- proper motion [Motus proprius.], 4.
- its proper motion, although it appeared non-uniform, was nevertheless regular right to the end [Motus proprius, licet inæqualis apparuerit, regularis tamen usque ad finem extitit.], 131.
- hourly motion for each day [Motus horarius ad ſingulos dies.], 109.
- true motion in the trajectory [Motus verus in Trajectoriâ.], 891, 892.

- The comet of 1652: its nuclei decreased greatly within a few days [Cometæ 1652 nuclei paucis diebus valdè decrevêre.], 415.
  - the observation made at Aleppo agrees very well with the Author's [Obſervatio Alepi habita, cum Auctoris optimè conſentit.], 889.
  - the Author's observations [Obſervationes Auctoris.], 5, 6,7, 8, 9, 10, 11, 12, 13, 14, 15, 887.
  - the observation at Digne [Obſervatio Dinienſis.], 159.
  - its position relative to the Pleiades [ad Plejadas conſtitutio.], 163.
  - the observation of Cornelius Malvaticæus [Obſerv. Cornelii Malvaticæi.], 325.
  - Wendelen's observation [Obſervatio Wendelini.], 324, 888.
  - its parallax was far smaller than the parallax of the Moon [Parallaxis, lunæ parallaxi longè fuit minor.], 136.
  - parallax [Parallaxis.], 888.
  - how great was the parallax on January 4? [Parallaxis quanta die 4 Januarii extitit ?], 311.
  - vertical parallaxes for each day [Parallaxes verticales ad ſingulos dies.], 312, 313.
  - the phenomena are explained very well by the diagram and the theory [Phænomena ex Schemate & Theoriâ optimè explicantur.], 631.
- The comet of 1652: that its position was in the aether is demonstrated by a solid argument [Cometæ 1652 Sedem in æthere fuiſſe, ſolido demonſtratur argument[[o/ó]].], 131, 147.

    - that its position in no way was, or could have been, in the elementary region [Sedem nullo modo fuisſe vel esſe potuisſe in regione Elementari.], 140, 146, 147, 148, 149, 150, 151, 152, 153.
    - situation of the trajectory [Trajectoriæ Situs.], 891.
- The theory: whether it agrees exactly with the observations is investigated [Theori[[a/á]], an cum obſervationibus apprimè reſpondeat ? inquiritur.], 630 and following.
- The comet of 1661: a most evident alteration as to the head [Cometæ 1661 Alteratio quoad caput evidentisſima.], 722.
    - first apparition [Apparitio prima.], 720.
    - how great the variation of the angle of inclination was [Anguli inclinationis variatio quanta extiterit.], 743.
    - variation of the angle of the orbit, and also of the point of intersection, for each day [Anguli Orbitæ variatio, nec non non puncti interſectionis ad dies ſingulos.] [recte: nec non puncti], 741.
    - the data and results of the calculation, set out in a table [Calculi data & producta Tabulâ incluſa.], 733.
    - there were various nuclei in the head [Capiti diverſi inerant nuclei.], 416, 721.
    - shape, colour, size and light of the head [Capitis figura, color, magnitudo, lumen.], 417,720, 721, 723, 745, 892.
    - from day to day the head appeared dimmer and the nuclei more confused [Caput in dies obſcurius nucleiq́; confuſiores apparuerunt.], 722.
    - the head did not present a perfect roundness [caput non abſolutam retulit rotunditatem.], 723.
    - the tail turned aside from the point opposite the Sun [Cauda à Solis oppoſito deflexit.], 893.
    - colour and light of the tail [Caudæ color & lumen.], 721, 722, 723.
    - direction and extension of the tail [Caudæ directio, & exporrectio.], 746,892, 894.
    - reciprocation of the tail [caudæ reciprocatio.], 893.
    - true length of the tail [caudæ vera longitudo.], 720;721,722, 746, 892.
    - the tail darted frequent rays [cauda radios vibrabat frequentes.], 510, 721.
    - the tail revives [cauda reviviſcit.], 723.
    - the body appeared much larger through the telescope [Corpus per Teleſcopium longè majus apparuit.], 894.
    - what its course was like [Curſus qualis extitit.], 724, 892.
    - deviation from a great circle [Deviatio à circulo maximo.], 720.

    - the apparent and the true diameter nevertheless increased, although the distance from the Earth increased continually [Diameter apparens & vera nihilominùs aucta fuit, licet diſtantia à Terrâ continuò increverit.], 774.
    - distance from the Earth [Diſtantia à Terrâ.], 892.
    - how its track, or progress, is preserved [Ductus ſeu progreſſus quomodo conſervatur.], 724.
    - duration [Duratio.], 892.
    - general history [Hiſtoria generalis.], 720.
- The comet of 1661: its distance from the Earth, together with its true motion, is found quite precisely by the drawing of the diagram alone [Cometæ 1661 Intervallum à Terrâ cum motu vero, ſolo Schematis ductu ſatis præcisè detegitur.], 746.
    - the intersection of the trajectory trace: at what place it occurred [Interſectio veſtigii Trajectorii,quo loco accidit.], 746.
    - length of its path [Itineris longitudo.], 743.
    - its visible place, with respect both to the ecliptic and to the equator, is set out in a table [Locus viſus tam reſpectu Eclipticæ, quàm Æquatoris tabulâ exponitur.], 736,737,738.
    - the place at which it first came to rest [locus, quo primùm reſederit.], 720.
    - size of the diameter, both as regards the nuclei and as regards the more diluted matter adhering [Magnitudo Diametri, tam ratione nucleorum, quàm materiæ dilutioris adhærentis.], 723.
    - its greatest speed, and its perigee according to the Author's calculation [maxima velocitas, & Perigæum juxta calcul. Auctoris.], 781.
    - apparent proper motion [Motus apparens proprius.], 892.
    - daily and hourly motion in its orbit [Motus diurnus & horarius in ſuâ Orbitâ.], 740, 742.
    - ephemeris of the motion, with respect both to the ecliptic and to the equator, for each day of the apparition [Motûs Ephemeris, tàm reſpectu Eclipticæ, quàm Æquatoris ad ſingulos apparitionis dies.], 741.
    - proper motion, the angle of the orbit and the ecliptic, and also the node [Motus proprius, Angulus Orbitæ & Eclipticæ nec non Nodus.], 739.
    - true motion in the trajectory [Motus verus in Trajectoriâ.], 893.
    - how great the diameter of the inner nucleus was [Nuclei interioris Diameter, quanta extiterit.], 774.
    - observations made by the Author at Danzig in the month of February, and in March and the following months [Obſervationes ab Auctore Gedani Menſe Febr. & Martio & ſequent. peractæ.], 416,725,726, 727,728,729,730,892.

    - with what instruments the observations were made [obſervationes quibus inſtrumentis ſunt peractæ.], 724.
    - observations of the tail made by the Author at Danzig [obſervationes quoad caudam Gedani ab Auctore peractæ.], 458,459.
- The comet of 1661: the observation made at Olomouc [Cometæ 1661 obſervatio Olmitii habita.], 894.
    - its orbit, curved or almost conic, is saved by means of a nearly straight line [Orbita curva vel penè conica, per lineam propemodùm rectam ſalvatur.], 746.
    - parallax [Parallaxis.], 744, 892.
    - theory and diagram [Theoria & Schema.], 746.
    - since its trajectory was in reality curved, its motion cannot be correctly derived by means of tangents [Trajectoria cùm reverà extiterit incurvata, motus ejus per tangentes derivari rectè haud poteſt.], 747.
    - inclination of the trajectory [Trajectoriæ inclinatio.], 747.
    - the place where the trajectory curved most [Trajectoria quo loco ſe maximè inflexit.], 747.
    - situation of the trajectory [Trajectoriæ Situs.], 893.
- The comet of 1664: how great its deflection from a straight path was [Cometæ 1664 à recto tramite deflexio, quanta extiterit.], 896.
    - the main points of the calculation are set out in certain little tables [Calculi capita Tabellis quibusdam exhibentur.], 762.
    - the calculation agrees remarkably well with the figure, although it is founded on an entirely straight trajectory [calculus cum Iconiſmo egregiè conſentit, licet in trajectoriâ planè rectâ fundatus ſit.], 764.
    - the calculation was most laborious [calculus fuit laborioſisſimus.], 762.
    - calculation for the theory [calculus pro Theoriâ.], 762 and following.
    - the head grew gradually, as the thinner matter condensed [Caput paullatim crevit, condenſante materiâ tenuiori.], 894.
    - the head decreased as to its appearance [Caput quoad apparentiam decrevit.], 894.
    - the striking deviation and extension of the tail [Caudæ deviatio atqueexporrectio inſignis.], 774,896.
    - the tail was somewhat curved [Cauda nonnihil fuit incurvata.], 895.
- The comet of 1664: its tail revived at intervals [Cometæ 1664 cauda, per intervalla reviruit.], 896.
    - course [Curſus.], 759.
    - distance from the Earth [Diſtantia à Terrâ.], 897.
    - inclination of the coma [Inclinatio comæ.], 895.
    - the distances from the diagram and the calculation are compared with those from the observations [Intervalla ex Schemate & calculo, cum illis ex obſervationibus conferuntur.], 765.

- how great its distance from the Sun was [intervallum à Sole quantum extiterit.], 766.
- its radiance was displayed upward like a peacock's tail [Jubar, inſtar caudæ Pavonis ſurſum exponebatur.], 895.
- proportion of its size to the Earth [Magnitudinis proportio ad Terram.], 895.
- the size of the head: how much larger than the Earth it was [Magnitudo capitis, quanta extitit terrâ amplior.], 774.
- size and variation of the angle of inclination [magnitudo & variatio anguli inclinationis.], 896.

- The comet of 1664: its apparent motion, however non-uniform, was nevertheless most regular [Cometæ 1664 Motus apparens ut ut inæqualis, regularisſimus tamen extitit.], 896.
  - its daily motion according to the hypothesis from tangents is restored by the motion of the nodes [motus diurnus juxta hypotheſin ex tangentibus, motu Nodorum reſtituitur.], 789.
  - what its motion from the Sun was like [motus ex Sole qualis extitit.], 766.
  - its daily motion in the trajectory is shown in a little table [motus in trajectoriâ diurnus,Tabellâ exhibitur.] [recte: exhibetur], 765.
  - true motion in the trajectory [motus verus in Trajectoriâ.], 897.
  - obliquity of the trajectory [Obliquitas Trajectoriæ.], 897.
  - the parallaxes from the diagram correspond accurately to the same parallaxes from the observations and the calculation [Parallaxes ex Schemate, iisdem ex obſervationibus & calculo accuratè reſpondent.], 765.
  - parallax [Parallaxis.], 758.
  - by what method the parallax was investigated by the Author [Parallaxis quâ ratione ab Auctore fuit explorata.], 756 and 757.
- The comet of 1664: the observation of Pierre Petit [Cometæ 1664 obſervatio P. Petiti.], 895.
  - explanation of the diagram [Schematis dilucidatio.], 760.
  - position [Sedes.], 897.
  - situation with respect to the ecliptic [Situs reſpectu Eclipticæ.], 896.
  - why was its trajectory straighter than that of the comets of 1661 and 1665? [Trajectoria cur rectior, quàm Cometæ 1661 & 1665 extiterit ?], 760, 761.
  - inclination of the trajectory [Trajectoriæ inclinatio.], 759.
  - curving and situation of the trajectory [Trajectoriæ incurvatio & ſitus.], 897.
  - the trajectory advanced outside the annual orbit, above the sections [Trajectoria extra orbem annuum ſupra ſectiones inceſſit.], 759.

    - by how great a distance the trajectory stood off from the great orb at its least remove [Trajectoria, quanto intervallo ab orbe magno in minimâ diſtitit remotione.], 760.
- The comet of 1664: its greatest speed, and its perigee according to the Author's calculation [Cometæ 1664 Velocitas maxima & Perigæum,juxta calculum Auctoris.], 787.
- The comet of 1665: variation of the angle of inclination and of the nodes [Cometæ 1665 Anguli inclinationis, atque Nodorum variatio.], 900.
    - variation of the angle of obliquity [Anguli obliquitatis variatio.], 771.
    - angle of inclination [Angulus inclinationis.], 768.
    - apparition [Apparitio.], 897.
    - apparent size of the head [Capitis magnitudo apparens.], 898.
    - light, or brilliance, of the head [capitis lumen ſeu ſplendor.], 898.
    - the head and the tail darted frequent rays [Caput caudaq; radios vibrabat frequentes.], 899.
    - the tail was subject to deviation [Cauda deviationi fuit obnoxia.], 899.
- The comet of 1665: colour [Cometæ 1665 Color.], 898.
    - its course was entirely different from the course of the other comets [Curſus à reliquorum Cometarum curſu planè fuit diverſus.], 768.
    - its course was direct [curſus extitit directus.], 899.
    - its course with respect to the stars [curſus ratione ſiderum.], 899.
    - distance from the Earth [Diſtantia à terrâ.], 771, 900.
    - shape [Figura.], 898.
    - the cleft that it showed, as it were, in its coma [Fisſura, quam in comâ quaſi exhibuit.], 898.
    - diagram of the hypothesis [Hypotheſeos Schema.], 768.
    - distance from the Sun [Intervallum à Sole.], 772.
- The comet of 1665: its longitude deduced from the hypothesis agrees exactly with the observed longitude [Cometæ 1665 longitudo ex hypotheſi deducta, cum obſervatâ ad unguem convenit.], 770.
    - the matter at the front of the head vanished [Materia in fronte capitis evanuit.], 899.
    - motion from the Sun [Motus ex Sole.], 772.
    - how the motion increased, but in what way it diminished for 1664, is clear from the little table [Motus quomodo auctus, 1664 verò quâ ratione diminutus fuerit, ex tabellâ liquet.], 772.
    - the true motion increased from day to day [Motus verus in dies crevit.], 771, 900.
    - proportion of the inner nucleus to Jupiter and Saturn [Nuclei interioris proportio ad Jovem & Saturnum.], 898.
    - the inner nucleus cast, as it were, a shadow into the tail itself [Nucleus interior in ipſam caudam quaſi umbram projecit.], 898.

- parallax [Parallaxis.], 900.
- diagram, calculation and observations agree very closely [Schema, calculus & obſervationes apprimè concordant.], 771.
- the trajectory was not an entirely straight line [Trajectoria non fuit linea omninò recta.], 900.

- The comet of 1665: its trajectory was oblique [Cometæ 1665 Trajectoria obliqua extitit.], 770.
  - at what angle of obliquity the trajectory advanced [Trajectoria ſub quo angulo obliquitatis procesſerit.], 768.
  - its greatest speed, and its perigee according to the Author's calculation [Velocitas maxima, & Perigæum ſecundùm calculum Auctoris.], 781.
  - its trace advanced above the sections of the lines of sight, and within the annual orbit [Veſtigium ſupra ſectiones viſoriarum,& intra orbem annuum incesſit.], 768.
- The comet of 1665: its countenance was unchanging through almost its whole duration [Cometæ 1665 Vultus per totam ferè durationem fuit invariabilis.], 773.
- Comets display degrees of acceleration and of retardation [Cometæ accelerationis, ac retardationis gradus exhibent.], 629.
- Comets are not at all suited to a motion of circumrotation [Cometæ ad motum circumrotationis minimè ſunt apti.], 430.
  - removed to 20 miles from the Earth: a remarkable parallax with respect to latitude and declination [ad 20 Mill. à Terra remoti, mirabilis diverſitas adſpectûs ratione Latit. & Decl.], 147.
  - how many have been observed since the creation of the world? [à mundo condito quot fuerint obſervati ?], 451.
  - do they all run an equal course? [an æqualem omnes exerceant curſum ?], 677.
  - are they produced only at a certain time of the year? [an certo tantum anni tempore producantur ?], 425.
  - do they, because of the variation of the angle, necessarily move in some smaller circle? [an ex anguli variatione necesſariò in minori aliquo moveantur circulo ?], 104.
  - do they always grow most vigorous and flourish midway along their path? [an in mediâ ſemper itineris viâ maximè vigeſcant, & floreſcant ?], 677.
  - do all and each possess an entirely equal distance from the Earth, and measure it out at an equal speed? [an omnes & ſinguli æquale omninò à terrâ intervallum posſideant, & pari illud velocitate emetiantur ?], 320.
  - are all and each removed farther and farther from the Earth? [an omnes & ſinguli à terrâ magis magisq; removeantur ?], 320.

    - are they carried at an equal speed, as regards their motion? [an pari velocitate, quà motum ferantur ?], 689.
- Comets: do they always cross the plane of the ecliptic at some fixed angle? [Cometæ, an planum Elipticæ ſub certo aliquo angulo ſemper trajiciant ?] [recte: Eclipticæ], 588.
    - can they be predicted? [an prædici poſſint ?], 427.
    - do they always display equal degrees of speed at fixed times? [an ſtatis ſemper temporibus æquales velocitatis gradus exerceant ?], 690.
    - do they always proceed under a perpendicular line? [an ſub lineâ perpendiculari ſemper incedant ?], 588.
- Comets farther from the plane of the ecliptic: do they display the greatest latitudes? [Cometæ à plano Eclipticæ remotiores, an maximas exhibeant latitudines ?], 767.
    - with a very short beard [barbâ perbrevi.], 519.
    - bearded and tailed: how they differ [barbati, & caudati quomodo differunt.], 439.
    - two seen at the same time [bini ſimul conſpecti.], 798, 835, 842, 875.
    - they never cast their tails toward the side opposite Venus [Caudas in adverſam Veneris partem nunquam projiciunt.], 462.
    - for certain reasons they can be deflected from the course they have taken [certis de cauſis deflecti à ſuſcepto itinere poſſunt.], 648.
    - they do not rotate about an axis [circa axem non gyrantur.], 430.
    - they do not possess a constant and invariable size [conſtantem, & invariabilem magnitudinem non poſſident.], 774.
    - haired comets, even if they are carried under a great circle, can nevertheless move under different lines [criniti,etiamſi ſub circulo ferantur maximo,poſſunt tamen ſub diverſis lineis moveri.], 559.
    - they can be compared with the spots of the Sun as regards both true and apparent motion [cum maculis Solis, tam quoad motum verum, quàm apparentem comparari poſſunt.], 694, 697.
    - how do they differ from the spots of the Sun in their proper motion? [cum maculis Solis in motu proprio quomodo differunt ?], 697.
    - why do they deviate from a straight path? [cur ab itinere recto devient ?], 656.
    - why are they mostly carried toward the north? [cur ad Septentrionem plerumque ferantur ?], 716.
    - why do they turn one flat side or the other toward the Sun? [cur alterutrum latus planum Soli obvertant ?], 657.
    - why were they neglected by the ancients? [cur à Veteribus ſint neglecti ?], 437.
    - why do they appear smaller and paler around their disappearance? [cur circa diſparitionem minores & pallidiores appareant ?], 562.

- why do they usually grow quickly near the Sun? [cur circa Solem plerumq́; velociter excreſcant?], 649.
- why do they grow large more quickly than solar spots, so that they can be seen? [cur citiùs maculis Solaribus grandeſcant, ut conſpici queant ?], 711.
- why can they not move in an entirely straight line? [cur in lineâ omninò rectâ moveri non posſint ?], 658.

- Comets: why do they not twinkle, but usually appear with a mournful and gloomy face? [Cometæ, cur non ſcintillent, ſed lugubri ac triſti facie plerumq́ue appareant ?], 431.
  - why do not all of them meet the eye? [cur non omnes in oculos incurrant ?], 651.
  - why are most of them pale and somewhat livid? [cur pleriq́ue ſint pallidi & ſublividi ?], 388.
  - why do they usually decrease before they enter the great orb? [cur plerumq́ue decreſcant, antequam orbem magnum intrent ?], 385.
  - in their course they sometimes seem to describe a convoluted, manifold line [curſu ſuo nonnunquam lineam involutam multiplicem deſcribere videntur.], 670.
  - why do they display such dissimilar and such inconstant tails? [cur tam disſimiles, & adeò inconſtantes referant caudas ?], 503.
  - why are they so rarely seen? [cur tam rarò conſpiciantur ?], 651, 652.
  - pointed comets are the most frequent of all [cuſpidati omnium ſunt frequentisſimi.], 450.
- Comets are subject to a twofold real deviation [Cometæ deviationi reali duplici ſunt obnoxii.], 588.
  - they can put on a different face [diverſam induere posſunt Faciem.], 418.
  - if two perfect comets met each other, what would happen? [duo perfecti, ſi ſibi mutuò obviam venirent, quid accideret ?], 652.
  - two seen together in the morning [duo manè ſimul conſpecti.], 876.
  - two are not rarely passed off by ancient authors as a single one [duo haud rarò ab Auctoribus antiquis pro unico venditantur.], 793.
  - they exercise two principal motions, the one extrinsic or violent, the other intrinsic or natural [duos præcipuos exercent Motus, alterum extrinſecum ſeu violentum, alterum intrinſecum ſeu naturalem.], 666.
  - equine comets: of what kinds are they, and how many sorts are there? [Equini quales & quotuplices ſint ?], 442.
- Comets and projectiles: how do they differ in the speed of their motion? [Cometæ & exploſa, quomodo ratione motus velocitatis discrepant ?], 668.
  - and solar spots have similar properties [& maculæ Solares ſimiles habent affectiones.], 433.

    - and solar spots: in what do they disagree as regards their proper apparent motion? [& maculæ Solares in quibus, quoad motum proprium apparentem disconveniunt ?], 697.
- Comets and new stars do not arise in the same way [Cometæ & novæ Stellæ non eâdem naſcuntur ratione.], 422.
    - they consist of different nuclei and bodies [ex diverſis nucleis corporibusq́; conſtant.], 338.
    - they are composed of very different nuclei [ex diverſisſimis componuntur nucleis.], 640.
    - they can appear suddenly, with great bulk [ex improviſo magnâ mole conſpici posſunt.], 711,712.
    - they are produced from the effluvia of the planets [ex Planetarum producuntur effluviis.], 434.
    - in the shape of a square [figurâ Quadrati.], 448.
    - resembling the shape of a lance [formam Lanceæ referentes.], 448.
    - they have nuclei [habent Nucleos.], 434.
    - the course of this one or that: why is it slower or faster? [hujus vel illius curſus,cur tardior vel velocior exiſtat?], 693.
    - resembling the figure of the Spit [imaginem Veru referentes.], 448.
    - set in the atmosphere, they are always carried toward the same quarter [in atmoſphærâ conſtituti, eandem ſemper versùs plagam feruntur.], 699.
    - in the atmospheres they grow thinner near the border, and move more slowly [in atmoſphæris circa limbum gracileſcunt, atq́ue tardiùs moventur.], 699.
    - at an equal distance from the perpendicular drawn from the Sun to the trajectory, are all equally swift? [in æquali diſtantiâ à perpendiculo in Trajectoriam ex Sole ducto, an omnes ſint æq́ue veloces ?], 677.
    - in twilight they always appear redder [in crepuſculo ſemper apparent rubicundiores.], 515.
    - in growing and in decreasing they take up an unequal span [in creſcendo & decreſcendo ſpatium conſumunt inæquale.], 423.
    - at a distance of 20 semidiameters of the Earth: variation of the motion [in diſtantiâ 20 Semid. Terr. Motûs variatio.], 161.
    - in the West Indies, in the year 1652, two were seen [in Indiâ occidentali anno 1652 duo ſunt conſpecti.], 433.
    - in their motion they keep the greatest regularity, even in the very irregularity of the motion? [in motu ſummam conſervant regularitatem,etiam in ipsâ motûs inæqualitate ?], 559.
    - they move in no line other than a parabolic one [in nullâ aliâ, quàm parabolicâ moventur lineâ.], 666.
    - generated in our vaporous orb, they can remain above the horizon for scarcely the space of an hour or two [in Orbe noſtro vaporoſo

progeniti, vix unius aut alterius horæ ſpatium ſupra horizontem commorari poſſunt.], 715.
    - in the more southern part of the world most of them perish, and they are very rarely observed [in parte mundi Auſtraliori pleriq́ue pereunt, & rariſſimè obſervantur.], 717.
    - they are generated in any part of the planetary system whatever [in quâcunq́ue parte ſyſtematis planetarii generantur.], 424.
- Comets: in what part of the world do very many perish and are very seldom observed [Cometæ, in quâ mundi parte plurimi pereant, & rarò admodùm obſerventur.], 717.
    - in some respects they are similar to solar spots [in quibusdam maculis Solaribus ſunt ſimiles.], 413.
    - they sometimes flash [interdum corruſcant.], 432.
    - they always remain within the limits of the planetary system [intra limites ſyſtematis Planetarii ſemper permanent.], 704,715.
    - in a situation 20 semidiameters of the Earth from the Earth they cannot be saved [in Situ à terrâ 20 Semid. Terr. ſalvari non poſſunt.], 162.
    - although they are supposed to lie under an equal inclination, their motion nevertheless varies [licet ſub æquali ſupponantur inclinatione; nihilominùs motus eorum variatur.], 690.
    - although they are removed 2580 miles from the Earth, all the difficulties nevertheless cannot be avoided [licet 2580 Mill. à terrâ removeantur, omnes tamen inconvenientiæ evitari haud poſſunt.], 157.
    - long-lived comets: does their trajectory, with so swift a course, grow almost to infinity? [longævi Trajectoria, anne curſu ipſo tam veloci, in infinitum penè excreſcat ?], 712.
    - from where do they draw their light? [lumen unde hauriant ?], 435.
    - they are always larger than they appear [majores ſemper ſunt, quàm apparent.], 334.
    - they are subject to a libratory motion, but do not revolve about an axis [Motui libratorio ſunt obnoxii, circa axem verò non circumvolvuntur.], 436.
    - they possess a supremely regular motion, although their progress seems most disordered [Motum ſummè regularem poſſident, licet videantur inceſsûs inordinatiſſimi.], 634.
    - in their motion they do not always seem to describe an entire section of a parabola [Motu ſuo non ſemper ſectionem parabolæ integram deſcribere videntur.], 668.
    - many cross neither the equator nor the ecliptic [multi nec Æquatorem, nec Eclipticam transgrediuntur.], 124.
    - many: for what reason do they not come into our view? [multi, quâ de causâ nobis non veniant in conſpectum.], 649.

- Comets seen in the time of Nero [Cometæ Neronis tempore viſi.], 803.
  - they by no means consist of fixed stars [neutiquam ex Stellis conſtant Fixis.], 561.
  - they are not generated from just any effluvia and aethereal evaporations [non ex quibusvis generantur effluviis, & Evaporationibus æthereis.], 428.
  - they are not generated from the effluvia of a single aethereal body [non ex unius corporis ætherei effluviis generantur.], 383.
  - how far some have deviated from a straight line [nonnulli quantum à rectâ lineâ deviaverint.], 563.
  - they sometimes appear with a most varied and highly remarkable face [nonnunquam diverſisſimâ facie, maximèq; admirandâ apparent.], 444.
  - not all and each of them meet the eye [non omnes & ſinguli in oculos occurrunt.], 425.
  - they do not cross entirely straight, but in part exorbitate [non omninò rectà trajiciunt, ſed ex parte exorbitant.], 678.
  - they are not spherical bodies [non ſunt corpora ſphærica.], 418.
  - they can cross by no motion other than a nearly straight one [nullo alio, quàm motu propemodùm recto trajicere posſunt.], 587.
  - they have no zodiac [nullum habent Zodiacum.], 434.
  - they are never found entirely like one another [nunquam prorſus ſibi ſimiles deprehenduntur.], 773.
  - the darker and weaker ones: why are they more frequent? [obſcuriores & debiliores,cur ſint frequentiores?], 345.
  - all those observed somewhat more accurately had a path that was not at all wandering and turbulent [omnes accuratiùs aliquantò obſervati,minimè vagum & tumultuoſum habuerunt iter.], 132.
- Comets: do all of them also complete an equal stretch of their path in equal times? [Cometæ omnes, an æqualibus temporibus æquale etiam itineris ſpatium peragant ?], 654.
  - why do all of them deviate from a straight path by a real motion, especially around their last apparition? [omnes, cur motu reali circa ultimam præſertim apparitionem à recto tramite devient ?], 563, 655.
  - do all and each cross the equator and the ecliptic according to a fixed law? [omnes & ſinguli, an ex certâ lege Æquatorem, Eclipticamq; trajiciant ?], 124.
  - all and each are subject to a reciprocating motion [omnes & ſinguli motui reciprocatorio ſunt obnoxii.], 709.
  - all and each assert the motion of the Earth [omnes & ſinguli motum terræ aſſerunt.], 589.
  - all move in a nearly straight line [omnes in rectâ propemodùm moventur lineâ.], 642.

    - all can be fittingly maintained in a trajectory, but by no means by circles [omnes in Trajectoriâ conſervari convenienter posſunt, per circulos verò minimè.], 632.
    - all argue for the motion of the Earth [omnes pro motu Terræ militant.], 780.
    - all those that pass by the Sun display a conic course [omnes, qui Solem prætervehuntur, curſum exhibent conicum.], 685.
    - the higher ones are usually paler than the redder ones [pallidiores plerumq́ue exiſtunt altiores rubicundioribus.], 389.
    - very few have been observed with precision [paucisſimi exquiſitè ſunt obſervati.], 590.
    - they are by no means defended by circles and an unvarying hypothesis [per Circulos & invariatâ hypotheſi neutiquam defenduntur.], 590.
- Comets are by no means saved by circular motion, but most successfully by nearly straight motion [Cometæ per motum circularem neutiquam, ſed per motum propemodùm rectum quàm felicisſimè ſalvantur.], 561.
    - more are produced in one age than in another [plures uno, quàm altero producuntur ſeculo.], 652.
    - nearly all are carried through the sphere of the Sun [propemodùm omnes per Solis feruntur ſphæram.], 386.
    - most need correction as regards their apparition [plurimi quà apparitionem correctione indigent.], 792.
    - because of their rectilinear motion they do not dwell in the air at once [propter motum rectilineum non ſtatim verſantur in aëre.], 563.
    - at what speed they are carried when they are the fastest of all [quâ ferantur velocitate, quando ſunt omnium velocisſimi.], 700.
    - what kind of motion they have [qualem habent motum.], 753.
    - as long as they remain in their native atmosphere, they are nothing but pure and simple spots of the planets [quamdiu in atmoſphærâ ſuâ natali commorantur, non niſi puræ putæq́; Planetar.ſunt maculæ.], 700.
    - as soon as they leave their atmosphere, they are subject to different motions [quamprimùm atmoſphæram egrediuntur, diverſis ſubjiciuntur motibus.], 699.
    - toward which quarter they curve the tail [quam plagam versùs caudam incurvant.], 501.
    - as long as they stay in their atmospheres, they agree entirely with the spots [quamdiu in atmoſphæris ſuis hærent, cum maculis omninò ſunt concordes.], 699.
    - when they deviate toward the Sun [quando ad Solem deviant.], 680.

    - when they meet our eyes with a conspicuous size in the shortest space of time [quando breviſſimo temporis ſpatio conſpicua magnitudine in oculos nobis incurrunt.], 710.
- Comets: when they compress the tail [Cometæ quando caudam comprimant.], 443.
    - when they show themselves with monstrous and broken-off tails [quando caudis ſeſe oſtendunt monſtroſis & abruptis.], 513.
    - when they shed their whole coma and yet in reality nourish a very large one [quando comam exuunt omnem, & maximam tamen reverà alunt.], 528.
    - when they bend their course from the Sun [quando curſum à Sole inflectunt.], 680.
    - when and how they advance entirely in a straight line [quando & quomodo in directum prorsùs progrediuntur.], 678.
    - when and how they enter on a station [quando & quomodo ſtationem ineunt.], 618.
    - when they are largest and densest [quando maximi & denſiſſimi.], 385.
    - when they deviate more, and again when less, from the path they have taken [quando magis, & rurſus quando minùs à ſuſcepto itinere deviant.], 678.
    - when they are faster even than Mercury [quando Mercurio etiam ſunt velociores.], 754.
    - when they are first seen by us [quando primùm à nobis conſpiciuntur.], 565.
    - when, while they appear smaller as regards their diameter, they are in reality usually larger [quando quà Diametrum apparent minores, reverà plerumque majores exiſtunt.], 675.
    - when they describe a semiparabola [quando ſemiparabolam deſcribunt.], 680.
    - when they are more solid and at the same time in reality smaller [quando ſolidiores, ſimul reverà minores ſunt.], 676.
    - when they seem to be retarded [quando retardari videntur.], 635.
    - at how great a speed they are carried in the trajectory [quantâ velocitate in Trajectoriâ ferantur.], 713.
- Comets: in what way they agree with the spots and differ from them [Cometæ quâ ratione cum maculis conveniunt & diſcrepant.], 699.
    - the darker they become, the larger their diameter becomes [quantò obſcuriores redduntur, tantò illorum Diameter fit major.], 346.
    - in what way, and from where, they produce their tails in such different fashions [quâ ratione Caudas ſuas, & undè tam diverſimodè procreant.], 469.
    - in what way and for what reason they exorbitate from a straight path, and are now slower, now faster [quâ ratione & quâ de causâ

à recto tramite exorbitant, atque nunc tardiores, nunc velociores exiſtunt.], 672.
- in what way they are moved [quâ ratione moveantur.], 644,648.
- in what way they are best of all distinguished and discerned [quâ ratione omnium optimè diſtinguantur, ac diſcernantur.], 439.
- why they abandon a direct course very quickly [quare curſum directum citisſimè deſerunt.], 678.
- four seen in one year [quatuor uno anno conſpecti.], 425,873.
- those that were seen by day while the Sun was shining [qui interdiu ſplendente Sole viſi fuêre.], 541.
- which seem to shed all uniformity in respect of deviation [quinam æqualitatem omnem exuere videantur ratione deviationis.], 492.
- which are bright and brilliant [quinam clari & ſplendidi.], 339.
- which are of a more constant colour [quinam coloris conſtantioris.], 389.
- which change colour in the trajection, and from what source [quinam, & unde colorem in Trajectione mutent.], 389.

- Comets: which are fastest at the beginning [Cometæ quinam initiò ſunt velocisſimi.], 696.
  - which are slowest at the beginning [quinam initio ſunt tardisſimi.], 696.
  - which are pale and dark [quinam pallidi & obſcuri.], 339.
  - which were faster than the rest [quinam præ reliquis fuêre velociores.], 753.
  - which are those in which curvature is found without inclination [quinam, in quibus curvatura absque inclinatione datur.], 498.
  - which are fastest of all [quinam ſunt omnium velocisſimi.], 671.
  - which are faster than others [quinam ſunt velociores præ aliis.], 694.
  - those that, by reason of their atmosphere, spring forth nearer around the equator are swifter in motion [qui ratione atmoſphæræ circa Æquatorem propiùs proſiliunt, ſunt motu concitatiores.], 694.
  - as regards their face they always differ [quoad faciem ſemper ſunt diverſi.], 773.
  - in what place they grow thinner and move more slowly [quo in loco gracileſcunt, atque tardiùs moventur.], 699.
  - in what place they proceed entirely straight [quo in loco rectà omninò procedunt.], 655.
  - the nearer they approach the Sun, the faster the course on which they are carried [quo magis ad Solem accedunt, eò velociori feruntur curſu.], 754.
  - how they are moved by God [quomodo à DEO moventur.], 644.
  - how they are distinguished by the moderns [quomodo à Recentioribus discernuntur.], 439.

    - how they were distinguished by the ancients [quomodo à Veteribus ſunt diſtincti.], 438.
    - how they are exactly defined and distinguished from others [quomodo exactè definiuntur, & ab aliis diſtinguuntur.], 439.
- Comets: how they grow [Cometæ quomodo excreſcunt.], 649.
    - how they exorbitate through the impressed motion and the inclination of the cometary disc [quomodo ex Motu impreſſo,& inclinatione diſci Cometalis exorbitant.], 568.
    - how they are moved [quomodo moventur.], 651.
    - how they are dissolved [quomodo reſolvuntur.], 649.
    - with what motion they are carried [quo motu feruntur.], 560.
    - the fewer and more solid the nuclei they consist of, the brighter they are [quò paucioribus,& ſolidioribus conſtant nucleis, eò ſunt lucidiores.], 344.
    - the nearer they are to the Sun, the brighter and longer the tails they display [quò Soli ſunt viciniores, eò lucidiores, & prolixiores exhibent caudas.], 541.
    - at what time they are born more quickly and more easily [quo tempore citiùs, faciliùsq́; naſcuntur.], 716.
    - how many could have been generated from those spots seen in the Sun in the year 1625 [quot ex iſtis maculis anno 1625 in Sole viſis generari potuiſſent.], 405.
    - how many can coagulate from solar matter in one year [quot uno anno ex materiâ Solari coagulari poſſunt.], 404.
    - they are the rarest phenomena of the heavens [rariſſima ſunt cœli phænomena.], 436.
    - how they are distinguished by reason of the beard [ratione barbæ quomodo diſtinguuntur.], 440.
    - as regards motion, they imitate the motion of disc-shaped bodies set in motion [ratione motus, æmulantur motum diſceorum commotorum corporum.], 674.
    - the more recent ones also submit to the Author's theory [recentiores, Theoriæ Auctoris quoq́ue ſeſe ſubjiciunt.], 774.
- Comets sometimes cross in a straight line [Cometæ rectà nonnunquam trajiciunt.], 678.
    - secondary ones: why do they usually deceive people's eyes? [ſecundarii, cur plerumq́ue hominum fallant oculos ?], 429.
    - they are always larger than they appear [ſemper ſunt majores, quàm apparent.], 435.
    - if they become brighter from day to day, it is a sign of immaturity [ſi in dies lucidiores fiunt, indicium eſt immaturitatis.], 346.
    - those rising together do not perish together [ſimul exorientes, non ſimul intereunt.], 435.

- do the individual comets each also show a similar motion? [ſinguli,an ſimilem etiam referant motum ?], 112.
- solar ones are faster than the rest [Solares præ reliquis ſunt velociores.], 695.
- in their own way they regard the Sun as their centre [Solem ſuo modo pro centro reſpiciunt.], 701.
- those presenting the appearance of a pole [ſpeciem Perticæ repræſentantes.], 448.
- they proceed beneath a circle that is nearly a great circle [ſub circulo incedunt propemodùm maximo.], 559.
- they are very diverse [ſunt admodùm diverſi.], 434.
- they are disc-shaped bodies [ſunt corpora diſcea.], 338.
- they are born on different centres [ſuper diverſis naſcuntur centris.], 422.
- they claim both a physical and an astronomical rising for themselves [tàm Ortum Phyſicum, quàm Aſtronomicum ſibi vendicant.], 433.
- being disc-shaped bodies, they reject circular motion [tanquam corpora diſcea, motum reſpuunt circularem.], 570, 571.
- they are born more readily at the time of the great conjunctions [tempore magnarum conjunctionum procliviùs naſcuntur.], 427, 716.

- Comets sometimes pass by the Earth itself [Cometæ terram nonnunquam ipſam prætervehuntur.], 759.
  - if the Earth is supposed immobile, they cannot in any way be saved by eccentrics [terrâ ſuppoſitâ immobili, per Eccentricos nullâ ratione ſalvantur.], 634.
  - they have a threefold age [triplicem habent ætatem.], 434.
  - they are subject to almost infinite variations [variationibus obnoxii ſunt penè infinitis.], 321, 322.
  - when they grow but little [ubi parùm [[á/a]]ugentur.], 649.
  - the true definition, or description, according to the Author's mind [vera definitio,vel deſcriptio ex mente Auctoris.], 390.
  - from what source, and when, they are slower and faster [unde,& quando tardiores velocioresq́; exiſtunt?], 675.
  - from what source, and in what way, they sometimes rise suddenly and then set again completely [unde,& quâ ratione nonnunquam ſubitò exoriantur, ac rursùs penitus occidant.], 349, 710.
  - from what source, and how, they often change their situation and their distance from the Earth [unde, & quomodo Situm ſuum, atq́; diſtantiam à Terrâ ſæpenumerò mutent.], 612.
  - from what source they become curved [unde incurventur.], 493.
  - from what source they seem to ascend toward the Pole and descend again to the ecliptic [unde versùs Polum aſcendere, & rursùs ad Eclipticam deſcendere videantur.], 641.

    - all of them project the tail toward the part opposite the Sun [univerſi caudam projiciunt in partem Soli adverſam.], 460.
    - all of them have been aethereal [univerſi extiterunt ætherei.], 153.
    - all of them move in a parabolic line [univerſi in lineâ moventur parabolicâ.], 659.
- Comets: all of them are mobile [Cometæ univerſi ſunt mobiles.], 559.
    - all of them, however very diverse they are, can nevertheless be comprised under the Author's hypothesis [univerſi, ut ut ſunt diverſiſſimi, ſub Auctoris hypotheſi tamen comprehendi poſſunt.], 776.
- Comets: as they grow, so too they decrease, more or less [Cometæ, ut creſcunt, ſic etiam ferè decreſcunt.], 414.
    - like the spots, they often change their shape [ut Maculæ, Figuram ſæpiùs mutant.], 412.
    - like the planets, they are moved by reason of inclination and nodes [ut Planetæ, moventur ratione Inclinationis atque Nodorum.], 123.
    - as pseudo-planets, they imitate the planets in their course, in their own way [ut Pſeudo-Planetæ,curſu,ſuo modo,Planetas imitantur.], 704.
    - are they moved by themselves, or by another? [utrum per ſe, an verò ab alio moveantur ?], 644.
    - do they always show a similar and the same conic section in their course? [utrum ſimilem, eandemq; ſemper coni ſectionem curſu ſuo referant ?], 583.
- Comets: their number from the year 480 before the birth of Christ [Cometarum ab anno 480 ante Chriſtum natum numerus.], 151.
    - their aspects also have their own operations [Adſpectus, ſuas quoque habent operationes.], 719.
    - some are malevolent, others benign [alii ſunt malevoli, alii benigni.], 719.
    - some were seen for eight months [aliqui per octo Menſes fuêre conſpecti.], 712.
    - the angle of the orbit: does it vary? [Angulus Orbitæ, an varietur ?], 104, 133.
    - aphorisms [Aphoriſmi.], 433.
    - their withdrawal from the Earth can be divined, more or less, from their colours [à Terrâ discesſus, ex coloribus propemodùm divinari poteſt.], 389.
    - atmospheres [Atmoſphæræ.], 432.
    - and the time of birth of new stars [atque novarum Stellarum naſcendi Tempus.], 426.
    - heads: when are they further from the very ends of the tails? [Capita, quando ipſis caudarum extremitatibus ſunt remotiora ?], 539.

- heads: in what way they were depicted and delineated by the Author [Capita, quâ ratione ab Auctore fuerunt depicta, atque delineata.], 441.
- head, tail and apparent daily motion: when do they appear greatest? [Caput, Cauda & Motus apparens diurnus,quando apparent maxima ?], 632.
- the head: when it is largest [Caput, quando eſt maximum.], 339.
- tails: do they sometimes come into view even without heads? [Caudæ, an etiam absque capitibus ſub adſpectum quandoque veniant ?], 557.
- tails: do they exist in the air, or in the aether? [Caudæ,an in aëre, an verò in æthere exiſtant ?], 459.
- tails: can they eclipse stars entirely? [Caudæ, an Stellas omninò eclipſare poſſint?], 516.
- tails and faces: of how many kinds they are [Caudæ, Faciesq; quotuplices ſint.], 437.
- three fiery tails seen at once, if it is right to believe it [Caudæ ignitæ tres ſimul viſæ; ſi credere fas eſt.], 832.
- blunter tails and the smallest fixed stars: in what way they are accurately recognised [Caudæ obtuſiores minutisſimæq; fixæ, quâ ratione accuratè cognoſcantur.], 332.

- Comets whose tails are wider in the middle necessarily appear to have larger heads [Cometarum Caudæ, quæ in medio ſunt ampliores, eorum capita neceſſariò videntur majora.], 537.
  - all tails borrow their light from the Sun [Caudæ univerſæ Lumen mutuantur à Sole.], 469.
  - the tail, when it lies higher than the Sun, is never seen with its genuine face [Cauda, quando Sole altior verſatur, genuinâ facie nunquam conſpicitur.], 537.
  - when the tail appears straight [Cauda quando videtur recta.], 500.
  - the tail can cover the Earth in its own time [Cauda terram ſuo tempore tegere poteſt.], 540.
  - the various kinds of tailed comets [caudatorum variæ ſpecies.], 440.
  - classes: how many are there? [Claſſes quot ſunt ?], 439.
  - the coma has nothing in common with their shadow [coma cum eorum umbrâ nihil habet commune.], 544.
  - the coma: in what way it sometimes seems to go off into different parts of the heavens, when in reality it inclines toward the side opposite the Sun [coma, quâ ratione in diverſas nonnunquam abire videatur cœli partes, cùm reverà in oppoſitum Solis vergat.], 554.
  - the kinds of comate, or haired, comets [Comatorum, ſive Crinitorum ſpecies.], 439,440.
  - bodies: what matter they consist of [Corpora ex quâ conſtant materiâ.], 561.

- the bodies are disc-shaped, like the spots [Corpora inſtar Macularum ſunt diſcea.], 419.
- the bodies are by no means eternal [Corpora neutiquam ſunt æterna.], 561.
- bodies: of what kind? [Corpora qualia ?], 434, 559.
- the bodies are temporary, according to the Author [Corpora ſunt temporanea juxta Auctorem.], 562.
- the matter of the bodies grows for a definite time and decreases again [Corporum materia certo tempore creſcit & rursùs decreſcit.], 383.
- the manner of growing [creſcendi ratio.], 434.
- the course: why is it faster in the place where the ray from the Sun falls perpendicularly? [Curſus, cur eo in loco, ubi radius ex Sole ad perpendiculum incidit, celerior ſit ?], 669.

- Comets: their course is in no way proved by means of circles [Cometarum Curſus per circulos nullo pacto evincitur.], 616.
  - their course: by what motion it is saved best of all [Curſus per quem Motum omnium optimè ſalvatur.], 616.
  - their course: in what way it becomes faster in the course of time and takes on increments [Curſus, quâ ratione tractu temporis velocior redditur atque incrementa ſumit.], 384.
  - their course: some have long since laboured to have it maintained in the aether [Curſus, ut in æthere conſervaretur, jam olim nonnulli deſudarunt.], 605.
  - method of finding their declination and right ascension from altitudes and azimuths [Declinationem & Aſcenſionem Rectam ex altitudinibus & azimuthis inveniendi Methodus.], 25.
  - the manner of decreasing [decreſcendi ratio.], 434.
  - their deviation tends toward the Sun near the end [Deviatio circa finem ad Solem tendit.], 667.
  - their deviations differ very greatly [Deviationes maximè differunt.], 774.
  - the diameter does not always grow in reality, although it appears to [Diameter non ſemper reverà, licet appareat, creſcit.], 346.
  - the true diameter necessarily varies [Diameter vera neceſſariò variatur.], 348.
  - the disc: is it always round? [Diſcus, an ſemper ſit rotundus ?], 349.
  - their first dissolution: where it usually tends to take place [Diſſolutio prima, ubi plerumq; fieri ſolet.], 383,386.
  - the distinction of Pliny the Elder [Diſtinctio Plinii.], 438.
  - their differing brightness and darkness: in what way it was represented [diverſa Claritas & Obſcuritas, quâ ratione fuerit expreſſa.], 441.

- Comets: their eclipses — are they total and partial? [Cometarum Eclipſes, num totales & partiales ſint?], 552.
    - the duration of their eclipses: can it be determined? [Eclipſium duratio, an definiri queat ?], 552.
    - and solar spots: their agreement [& Macularum Solarium convenientia.], 414.
    - almost every one of them exercises a motion of its own [ferè ſinguli peculiarem exercent Motum.], 320.
    - their kinds are very many [genera ſunt quàm plurima.], 439.
    - generation [Generatio.], 354,383,434,477.
    - there is no generation and corruption in the sublunary air [Generatio, & Corruptio in aêre ſublunari datur nulla.], 612.
    - there is generation and corruption throughout the whole aether [Generatio, & Corruptio per totum datur ætherem.], 435.
    - their generation does no harm to the planets [Generatio Planetis non officit.], 436.
    - the end and purpose of their history, written by the Author [Hiſtoriæ, ab Auctore conſcriptæ finis & ſcopus.], 791, 792.
    - the history of the later ones has been set out more fully by the Author [Hiſtoria poſteriorum,ab Auctore copioſiùs eſt expoſita.], 793.
    - their history: to what end did the Author write it, and what did he chiefly attend to in it? [Hiſtoriam, quem in finem Auctor conſcripſerit,& quænam præcipuè in illâ attenderit ?], 791, 792.
    - horizontal parallaxes of the comet of 1652 [horizontales parallaxes Com. 1652.], 311,312, 313.
    - the increases and decreases of their progression depend on no proportion [incrementa & decrementa progreſſionis à nullâ dependent proportione.], 696.
- Comets: their inclination with respect to the trajectory [Cometarum Inclinatio ratione Trajectoriæ.], 421.
    - their paths usually describe an obtuse section, arising from obtuse cones [itinera ſectionem plerumque obtuſam, ex obtuſis conis exortam deſcribunt.], 684.
    - definition according to Aristotle and his followers [juxta Ariſtotelem ejusq; Sectatores definitio.], 352.
    - description and distinction of the lamp-shaped comets [Lampadiformium deſcriptio,& diſtinctio.], 442.
    - how far their greatest latitude extends [Latitudo maxima quousque ſeſe extendit.], 538.
    - the line of their path: of what kind is it? [Linea itineraria cujus generis eſt ?], 588.
    - their place and distance are known only through parallaxes [Locus, & Diſtantia non niſi per Parallaxes cognoſcitur.], 164.

- the place in which they were born, and their distance, can be gathered to some extent from their colour [Locus in quo prognati, & Diſtantia, ex colore quadantenus colligi poteſt.], 389.
- method of computing their longitudes and latitudes from different distances [longitudines, & latitudines ex diverſis diſtantiis ſupputationis Methodus.], 35, 36.
- the way of knowing their matter [Materiam cognoſcendi ratio.], 388.
- their matter contributes something to their motion [Materia, motui eorum nonnihil contribuit.], 693.
- their matter does not always consist of the evaporations of all the planets [Materia non ſemper ex omnium Planetarum Evaporationibus conſtat,], 387.
- their matter: of what kind is it? [Materia qualis eſt ?], 358.
- the more compact the matter, the brighter the comets are [Materia, quò eſt compactior, eò lucidiores ſunt Cometæ.], 344.
- their matter: where is it to be sought? [Materia ubi quærenda ?], 352.

- Comets: their variety as regards motion is very great [Cometarum maxima eſt quoad motum varietas.], 698.
  - bulk [Moles.], 424.
  - Kepler was the first of all to attempt to demonstrate their motion by straight lines [Motum per lineas demonſtrare rectas, primus omnium tentavit Kepplerus.], 591.
  - their daily motion is very diverse [Motus diurnus eſt diverſisſimus.], 322.
  - their motion is partly retarded by the inclination of the disc, or even stopped entirely [Motus ex inclinatione diſci partim retardatur,vel planè etiam ſiſtitur.], 667.
  - their motion is also retarded and accelerated by the rarity and density of the cometary matter [Motus, ex raritate & denſitate materiæ cometicæ quoque retardatur, & acceleratur.], 676.
  - on the Ptolemaic theory their motion becomes far slower [Motus ex Theoriâ Ptolemaicâ longè fit tardior], 703.
  - in what respects does their motion differ from the motion of thrown or fired bodies? [Motus in quibusnam à projectorum,vel exploſorum Motu differt ?], 668,677.
  - their motion in the trajectory is indeed non-uniform, but by no means disordered [Motus in Trajectoriâ quidem eſt inæqualis, ſed minimè inordinatus.], 676.
  - what their motion is like according to the Author [Motus juxta Auctorem qualis eſt.], 568.

    - neither the true nor the apparent motion is correctly determined by tangents [Motus nec verus, nec apparens per tangentes rectè definitur.], 777.
    - their motion never becomes entirely straight [Motus nunquam omninò fit rectus.], 680.
    - parabolic motion [Motus parabolicus.], 680.
    - their motion is demonstrated best of all by the motion of sailing [Motus per Motum velificationis omnium optimè demonſtratur.], 577.
- Comets: when and how their motion increases [Cometarum Motus quando & quomodo augetur.], 672.
    - when is their motion intensified and relaxed? [Motus quando intenditur & remittitur ?], 688.
    - why and from what source does their motion grow, and decrease again? [Motus quare & unde creſcit,rurſusq́; decreſcit?], 674.
    - how their motion is carried out in a parabolic line, and then how the inclination of the disc varies unceasingly, is shown by a diagram [Motus quomodo in lineâ peragitur parabolicâ; tùm quomodo inclinatio diſci indeſinenter variatur, Schemate declaratur.], 670.
    - what promotes the retardation of their motion [Motûs retardationem quid promoveat.], 676.
    - their motion is explained by a diagram [Motus Schemate dilucidatur.], 571.
    - how their motion stands with respect to the planets [Motus quomodo ſe habet reſpectu Planetarum.], 700.
    - where their motion is faster [Motus ubi eſt celerior.], 669, 675.
    - where their motion is slower [Motus ubi eſt ſegnior.], 675.
    - from what source, and when, their motion varies [Motus unde,& quando variatur.], 675.
    - how marvellous their very swift motion is [Motus velocisſimus quàm admirandus.], 702.
    - their true proper motion in the trajectory is to be considered both from the Earth and from the Sun [Motus verus proprius in trajectoriâ tàm ex terrâ, quàm ex Sole conſiderandus eſt.], 700.
    - the manner of their birth and growth [naſcendi & creſcendi ratio.], 412.
    - when their birth occurs [Nativitas quando contingit.], 718.
    - no one is granted exact knowledge of the time of their birth [Nativitatis tempus exactè compertum habere, nemini conceditur.], 718.
    - the undertaking is almost the most difficult of all [Negotium omnium ferè eſt difficillimum.], 139.
- Comets: some sometimes pass the Sun more closely than Mercury itself [Cometarum nonnulli Solem nonnunquam propiùs trajiciunt ipſo Mercurio.], 705.

- some: how many semidiameters of the Earth they have travelled in their whole duration [nonnulli, quot Semid. Terræ totâ ſuâ duratione peragraverint.], 715.
- sometimes a wonderful metamorphosis occurs [nonnunquam mira contingit metamorphoſis.], 526.
- some nuclei are brighter than others [Nuclei alii aliis ſunt ſplendidiores.], 435.
- the nuclei grow and decrease [Nuclei creſcunt, ac decreſcunt.], 435.
- the nuclei exercise a motion of their own [Nuclei peculiarem exercent Motum.], 436.
- none is entirely like another in every respect [nullus ab omni parte alteri omninò eſt ſimilis.], 560, 697.
- none has exactly followed the track of a great circle [nullus ductum exactè ſequutus eſt circuli maximi.], 777.
- none duly observed so far has been slower than Saturn as regards its proper motion, and in turn faster than Mercury [nullus hactenus debitè obſervatus, quà motum proprium tardior Saturno,atque vicisſim Mercurio velocior extitit.], 704.
- none is slowest in the middle of its path [nullus in medio itineris ſui eſt tardisſimus.], 696.
- none ever leaves the system of the planets [nullus Syſtema Planetarum unquam egreditur.], 754.
- obscuration by the shadow of the planets, or of the Earth, is rare [Obſcuratio ab umbrâ Planetarum, vel Terræ rara.], 551.
- observations: to what end are they to be made? [Obſervationes quem in finem ſunt inſtituendæ ?], 17.

- Comets: the inclinations of the orbit, and the nodes, of all comets were variable and mobile [Cometarum omnium Inclinationes Orbitæ, Nodiq; variabiles,ac mobiles fuére.], 122.
  - three more recent comets amply confirm the rise and decay described by the Author [Ortum & interitum ab Auctore deſcriptum abundè tres recentiores Cometæ ſtabiliunt.], 773 and following.
  - the method of knowing their rise, place and departure from the Earth [Ortum, Locum & à Terrâ discesſum cognoſcendi ratio.], 389.
  - rising and setting [Ortus & Occaſus.], 349.
  - their rising and setting can be clearly recognised from the comet of 1661 [Ortus & Occaſus ex Cometâ 1661 clarè cognoſci poteſt.], 416.
  - their physical rising and setting is proved and demonstrated chiefly by three examples [Ortus & Occaſus Phyſicus, tribus inprimis probatur & demonſtratur Exemplis.], 413.
  - from what source their pallor and obscurity come [Pallor & obſcuritas unde.], 431.
  - which parts dissolve first, before the total disappearance [partes quænam ante totalem diſparitionem prius disſolvuntur.], 435.

- the phenomena are by no means established by circles [Phænomena per Circulos nullo pacto evincũtur.], 616.
- all the phenomena are successfully saved by the trajectory [Phænomena univerſa feliciter Trajectoriâ conſervantur.], 637.
- the appearance of the pithei [Pitheorum facies.], 442.
- does the principal nucleus stand in the middle of the head? [præcipuus Nucleus, an in medio Capitis conſiſtat ?], 435.
- where most of those observed so far were first seen [pleriq́ue hactenus obſervati, ubi primùm ſunt conſpecti.], 681.

- Comets: their first birth [Cometarum prima Nativitas.], 384.
  - their first birth can never be observed exactly [prima Nativitas obſervari exactè nunquam poteſt.], 565.
  - their faculty of procreating and condensing [procreandi & condenſandi Facultas.], 392.
  - each one is subject to a different motion [quilibet motui obnoxius eſt diverſo.], 752.
  - which are less suited to motion [quinam ad motum minùs ſunt idonei.], 676.
  - which are more apt for motion [quinam ad motum ſunt habiliores.], 676.
  - which of all are the slowest [quinam omnium ſunt tardisſimi.], 695.
  - which of all are the fastest [quinam omnium ſunt velocisſimi.], 695.
  - why do their rays not always point entirely in a straight line? [Radii, cur non ſemper in directum omninò vergant ?], 472.
  - the apparent and true diameter of the more recent ones [Recentiorum apparens & vera diameter.], 773.
  - from what source their retardation comes [Retardatio unde.], 657,658.
  - their distance from the Earth is very diverse [Remotio à terrâ admodùm eſt diverſa.], 320.
  - of those duly observed, none has traversed even so much as the diameter of the great orbit [ritè obſervatorum nullus vel diametrum tantùm orbis magni emenſus eſt.], 715.
  - description of the secondary ones [ſecundariorum Deſcriptio.], 428.
  - each single one always keeps its own single course and position [ſingulus ſingularem perpetuò ſervat curſum, ſitumq́;.], 766.
  - how the position of the trajectory is determined [Situs Trajectoriæ,quomodo determinatur.], 593.
- Comets: their species [Cometarum Species.], 438,439.
  - their stations and retrogradations, above all with the Earth at rest, can by no means be explained by tangents [ſtationes & retrogreſſiones, terrâ imprimis ſtabili, per tangentes explicari haud posſunt.], 778.
  - how great their greatest speed was; namely, of the three later ones [ſumma velocitas quanta fuerit; trium ſc. poſter.], 781.

- none of the earlier ones has flown across the planetary system [ſuperiorum nullus Syſtema Planetarium transvolavit.], 776.
- the syrma is mostly fuller in the middle [Syrma in medio plerumq́ue fit amplius,], 536.
- their inequality and diversity as regards both distance and motion [tàm quoad Diſtantiam, quàm Motum inæqualitas & diverſitas.], 320.
- from what source so great a diversity in their appearance arises [tanta diverſitas in Facie unde appareat.], 418.
- a straight traversal: by what route it is more easily accomplished [Trajectio recta, quâ viâ faciliùs expediatur.], 776.
- in what place of the heavens the trajectory is set [Trajectoria quo cœli loco ponatur.], 629.
- the trajectory is thoroughly non-uniform [Trajectoria penitus eſt inæqualis.], 321.
- where the trajectory is straighter [Trajectoria ubi eſt rectior.], 761.
- whether the track is circular, elliptical, or rather parabolic, is recognised from the curvature of the trajectory [trames, an ſit Circularis,Ellipticus, an verò Parabolicus ? ex Trajectoriæ cognoſcitur incurvatione.], 683.
- the Author is convinced that the place of the three later ones, and their course, has been demonstrated amply enough [trium poſteriorũ locum, eorumq́; curſum abundè ſatis demonſtratũ eſſe,Auctor ſibi perſuadet.], 776.

- Comets: their shadow by no means produces the comet's tail [Cometar.Umbra, caudã Cometæ neutiquam efficit.], 544.
  - the shadow can be now longer, now shorter than the tail itself [Umbra, modò longior, modò brevior ipsâ caudâ eſſe poteſt.], 545.
  - the shadow can sometimes overshadow the planets [Umbra Planetas quandoq́; inumbrare poteſt.], 548.
  - how the shadow can obscure stars [Umbra quomodo Stellas obſcurare poteſt.], 548,549.
  - the shadow is always fainter than that of the planets [Umbra ſemper eſt dilutior Planetarum.], 544.
  - does each one always have different degrees of speed and slowness? [unusquisq́ue, an diverſos ſemper velocitatis ac tarditatis gradus obtineat ?], 321.
  - each one exercises its own peculiar motion [unusquisq́ue peculiarem ſuum exercet motum.], 559.
  - each one always claims something peculiar and singular for itself [unusquisq́ue ſemper peculiare aliquid & ſingulare ſibi vendicat.], 322.
  - observations demonstrate their variation [Variationem obſervationes demonſtrant.], 773.

    - varied in colour, and the origin of this [varius Colore,jusq́; Origo.] [recte: ejusq́;], 388.
    - the true distinction [vera Diſtinctio.], 431.
    - the true origin [vera Origo.], 354.
- Comets of 1531, 1532, 1533: the motion of the inclination of the orbit and of the nodes [Cometarum 1531, 1532, 1533 Motus Inclinationis Orbitæ & Nodorum.], 120.
    - of 1618 and 1652: the difference [1618 & 1652 Differentia.], 415.
    - of 1618, 1652 and 1661: delineation [1618, 1652 & 1661 Delineatio.], 413.
- Comets of 1661, 1664 and 1665: the true and apparent magnitudes of the heads, or of the diameters, are set out in a small table [Cometarum 1661, 1664 & 1665 veræ & apparentes Capitum,ſive Diametrorum magnitudines Tabellâ exhibentur.], 773.
- A comet is imagined by the Author that runs through the whole zodiac in a short space of time and stays in the aether for an entire year; and by his trajectory he frees it from all inconveniences [Cometam Auctor fingit, qui brevi temporis ſpatio totum Zodiacum percurrit, ac per integrum annum in æthere hæret, eumq́; ſuâ Trajectoriâ liberat ab omnibus inconvenientibus.], 636,637.
    - to set a comet in the air even at a distance of 17,000 miles: nothing is more absurd [in aêre etiam ad Diſtantiam 17000 Mill. ſtatuere, nihil abſurdius.], 162.
    - that a comet in the air can scarcely stay two hours above the horizon is demonstrated by a diagram and calculation [in aêre vix duas horas ſupra Horizontem commorari posſe, demonſtratur Schemate & Calculo.], 151, 152.
    - Tycho was the first of all to observe a comet accurately and to detect it [omnium primò Tycho accuratè obſervavit atq́ue detexit.], 452.
    - as regards its most marvellous motion and leap, the Author frees a comet from all inconveniences by his hypothesis [quà Motum Saltumq; mirificentisſimum inconvenientiis omnibus Auctor eximit hypotheſi ſuâ.], 635.
    - the comet of Regiomontanus: most people have judged it aerial [Regiomontani plurimi aêreum arbitrati ſunt.], 601.
    - that a comet can sweep through 5 signs of the zodiac in the space of 24 hours, and indeed with a most regular motion, is shown by a diagram and calculation [24 horar. ſpatio 5 Zodiaci ſigna tranare posſe, & Motu quidem regularisſimo,Schemate & Calculo declaratur.], 635.
- The comet of 1652 is proved to have existed in the highest, ethereal region [Cometam 1652 in ſummâ extitisſe regione æthereâ probatur.], 131, 136.
    - that the comet of 1652 by no means existed, or could have existed, in the elementary region the Author demonstrates by various and

infallible arguments [1652 nullo modo in regione extitiſe,vel exiſtere potuiſe Elementari, rationibus demonſtrat Auctor variis & infallibilibus.], 140 to 157.
    - that the comet of 1652 was beyond 2580 miles, indeed was higher, 8600 miles, is demonstrated from the observation at Digne and at Danzig [1652 ultra 2580 Mill. imò altiorem fuiſe 8600 Mill. ex Obſervatione Dinienſi & Dantiscanâ demonſtratur.], 161.
    - the comet of 1661 was ethereal [1661 æthereum fuiſe.], 745.
    - from what is it clear that the comet of 1661 described a curved, or conical, orbit? [1661 orbitam deſcripſiſe incurvatam, vel conicam, unde liquet ?], 742.
    - how it is recognised, from a diagram, that the comet of 1664 was at first a morning comet, then an evening one [1664 initiò matutinum, dein veſpertinum extitiſe, undé cognoſcitur ex Schemate.], 761.
    - the comet of 1664 is shown to obey the Author's theory entirely [1664 Theoriæ Auctoris omninò parere oſtenditur.], 767.
- Comets: the Americans observed three in the year 1652 [Cometas Americani anno 1652 tres obſervârunt.], 653.
    - it is not possible to recognise comets without a telescope [abſque Teleſcopio cognoſcere haud datur.], 473.
    - that comets have cast their tails opposite the Sun is proved by certain older comets [Caudas ſuas in oppoſitum Solis projeciſe, Cometis quibusdam vetuſtioribus probatur.], 460.
    - that comets are celestial is proved [eſe cœleſtes,comprobatur.], 131, 132, 135, 136.
    - and that they once appeared of immense size is proved by various examples [& olim immenſæ magnitudinis apparuiſe, variis probatur Exemplis.], 329.
- Comets: that they consist of very diverse corpuscles and nuclei is proved, above all by the comet of Theodosius, which shone like a sword [Cometas ex Corpusculis Nucleisq; conſtare diverſiſimis, Cometâ inprimis Theodoſii, gladii inſtar fulgentis,probatur.], 446.
    - the Author does not go so far as to contest that they consist of elementary matter [ex materiâ conſtare elementari,Auctor non usque adeò impugnat.], 563.
    - that they move outside the vaporous sphere is confirmed by evident argument [extra Sphæram verſari vaporoſam, evidenti corroboratur argumento.], 156.
    - the Author maintains that all genuine comets have existed in the aether [genuinos omnes in æthere extitiſe, Auctor ſtatuit.], 318.
    - it is confirmed that they have never remained at rest in the air [in aêre nullo tempore ſubſtitiſe, comprobatur.], 151, 152, 153.
    - that they have gone off in different directions is proved by examples [in diverſas abiiſe partes, exemplis probatur.], 653.

    - it is demonstrated that they advance along a straight track with a proportioned motion, and can nevertheless traverse 18 signs of the zodiac in a few months [in recto tramite Motu proportionato incedere,& nihilominùs 18 ſidera Signiferi Menſibus quibusdam peragere poſſe, demonſtratur.], 634.
    - it is demonstrated that far more than have so far been observed can be produced from the evaporations of the planets [longè plures, quàm hactenus quidem obſervati ſunt, ex Planetarum Evaporationibus procreari poſſe, demonſtratur.], 399.
    - that they are carried along the trajectory with a non-uniform motion [Motu in Trajectoriâ ferri inæquali.], 658.
- Comets: that they proceed with an almost straight motion has been amply demonstrated [Cometas Motu procedere propemodùm recto, affatim demonſtratum.], 654.
    - they are much more difficult to investigate by calculation than new stars [multò difficiliùs eſt Calculo perveſtigare, quàm novas Stellas.], 139.
    - the Author is surprised that more of them do not come into our sight [nobis in adſpectum non venire plures, Auctor admiratur.], 405.
    - it is conceded that they sometimes travel below the Moon, and indeed now and then touch the Earth itself [nonnunquam infra Lunam incedere, imò Terram interdum ipſam attingere, conceditur.], 319.
    - that all of them deflect from a straight track is demonstrated by a diagram [omnes à recto tramite deflectere, Schemate demonſtratur.], 678.
    - the Author proves all those whose observations were carefully recorded by means of a straight trajectory [omnes, quorum Obſervationes exquiſitè fuerunt annotatæ, per Trajectoriam rectam evincit Auctor.], 591, 592.
    - that they can sometimes pass through the very atmosphere of the Earth and its vaporous air does not conflict with the Author's view [quandoque ipſam Telluris atmoſphæram, aëremq; vaporoſum trajicere poſſe, Auctoris ſententiæ non obſtat.], 612.
    - that they can sometimes arise suddenly is confirmed by the examples of the spots [ſubitò nonnunquam exoriri poſſe, exemplis macularum comprobatur.], 711.
    - it cannot be concluded that they necessarily arise at the time of great conjunctions [tempore magnarum conjunctionum neceſſariò exoriri, concludi non poteſt.], 427.
- Comets: the Author lays down that all of them dwell in the aether [Cometas univerſos in æthere verſari, ſtatuitur ab Auctore.], 352.

- Comets: to attribute to them a motion so very swift that they would cross 2 miles in the space of a single minute: is it entirely contrary to reason? [Cometis adeò velocisſimum attribuere motum, ut nimirùm unius ſcrupuli ſpatio 2 Milliaria tranent, an rationi planè ſit abſonum ?], 706.
    - for those existing at a distance of 10 semidiameters of the Earth, the variation of the parallaxes [in Diſtantiâ 10 Semid.Terr. exiſtentibus,parallaxium variatio.], 160.
    - why does motion belong to them? [Motus cur competat ?], 559.
    - some real deviation befalls them all [omnibus Deviatio aliqua realis obvenit.], 656.
    - what refractions are to be applied to them [quales Refractiones ſint adhibendæ.], 257.
    - it is demonstrated in certain marvellous and quite admirable comets that they are subject to no other laws than those of the trajectory [quibusdam mirificis & planè admirandis demonſtratur, eos nullis aliis Legibus, quàm Trajectoriæ eſſe obnoxios.], 632,633.
- Cometary tails: how great the greatest length of all has been [Cometicarum Caudarum longitudo omnium maxima quanta extiterit.], 518.
- Cometary matter always presents a flat face toward the Sun and the Earth [Cometica Materia Faciem perpetuò planam Solem Terramq́; versùs exponit.], 420.
    - the chief matter is found in the orb of the Sun [Materia præcipua in Solis datur Orbe.], 386.
- The cometary shadow: its length and shape [Cometicæ umbræ longitudo & figura.], 545.
- The cometary body: from what source does its density come? [Cometici Corporis denſitas unde ?], 415.
    - the face of the body: when is the same face presented to the Sun and the Earth? [Corporis Facies, quando Soli & terræ exponitur eadem ?], 708.
- Cometary bodies: their figure, or form [Cometicorum Corporum Figura ſ. Forma.], 418.
- The cometary body: from the exhalations of which planet it is composed can be recognised fairly well from its colour [Cometicum Corpus, ex cujus Planetæ exhalation[[i/î]]bus ſit compoſitum, haud malè ex colore cognoſcitur.], 388.
- Cometography: how can it be helped? [Cometographiæ quomodo ſubveniatur ?], 791.
- Cometographers: most of them usually take delight in vain predictions and divinations [Cometographorum pleriq́ue vanis plerumq́ue oblectantur prædictionibus, & divinationibus.], 138.

    - most of them rarely investigate comets properly by the geometrical method [pleriq́ue Geometricâ viâ rarò Cometas debitè perveſtigant.], 139.
- The companion of Saturn: its size [Comitis Saturni Magnitudo.], 394.
- Things set moving in a circle constantly tend to recede from the centre [Commota in gyrum tendunt perpetuò, ut recedant à.centro.], 646.
- The motion of ships: the more water strikes the rudder, the more violent and oblique it is [Commotio navium, quò plus aquæ temonem ferit, eò eſt vehementior, & obliquior.], 580.
- A thing set in motion impresses its motion on all the things that it carries [Commotum, Motum ſuum inprimit rebus omnibus, quas ſuſtentat.], 664.
- The cone of the cometary tail of 1652: its size [Coni Caudæ cometicæ 1652 Magnitudo.], 544.
- The plan of Rothmann and Riccioli on behalf of the Peripatetics [Conſilium Rothmanni & Riccioli pro Peripateticis.], 317.
- A plan for how something can be soundly conjectured and divined from the colours [Conſilium, quâ ratione ex Coloribus ſolidè aliquid conjecturari & divinari posſit.], 389.
- The cone of the tail: does it imitate the cone of the shadow in form and figure? [Conus Caudæ,num Conum Umbræ quà formam, figuramq́; æmuletur ?], 544.
    - the cone of the tail: when is it longer, and shorter? [Caudæ, quando longior, & brevior eſt ?], 545.
- The Copernicans admit no straight motion in nature [Copernicæi nullum in Naturâ concedunt Motum rectum.], 663.
- Cornelius Gemma's accurate observation of the comet of 1577 [Cornelii Gemmæ accurata Obſervatio Cometæ 1577.], 852.
- Cornelius Gemma's observation of the comet of 1556 [Cornelii Gemmæ Obſervatio Cometæ 1556.], 855.
- Bodies: how equal bodies meeting one another are deflected [Corpora æqualia ſibi occurrentia, quomodo deflectuntur.], 650.
    - ethereal bodies: can they eject so much matter without loss that so many immense adventitious bodies can be generated? [ætherea, an tantùm Materiæ ſine detrimento ejicere posſint, quò tot immenſa Corpora aſcititia generari queant ?], 393.
    - all perfect ethereal bodies rotate on an axis [ætherea perfecta omnia ſuper axem rotantur.], 373.
    - temporary ethereal bodies never reach the perfection of the bodies of the same age [ætherea temporaria ad perfectionem coævorum corporum nunquam perveniunt.], 393.
    - all ethereal bodies continually breathe out effluvia of exhalations and vapours [ætherea univerſa, continuò halituum vaporumq́; exſpirant effluvia.], 644.

- all ethereal bodies: how far they agree with the Sun, the Moon and the Earth [ætherea univerſa, in quantum cum Sole, Lunâ & Terrâ conveniant.], 368.
- the ethereal bodies do not all rotate equally fast about an axis [ætherea univerſa non æque velociter circa axem rotantur.], 373.
- all ethereal bodies eject and breathe out more matter than the Earth [ætherea univerſa, plus Materiæ, quàm Terra ejiciunt, & exſpirant.], 394.
- all ethereal bodies undergo, each in its own way, a reciprocal influence [ætherea univerſa reciprocum patiuntur ſuo modo influxum.], 372.
- celestial bodies are driven round in a circle without ceasing together with their atmosphere [cœleſtia cum ſuâ atmoſphærâ indeſinenter in orbem aguntur.], 644.
- all celestial bodies have their own atmospheres, in which generations and alterations occur in their own way [cœleſtia univerſa ſuas habent atmoſphæras, in quibus ſuo modo Generationes,& alterationes accidunt.], 357.

- The bodies of comets, and in particular the head of the comet of 1618, by no means consisted of very small fixed stars, according to Cysat [Corpora Cometarum & in ſpecie Cometæ 1618 caput juxta Cyſatum neutiquam ex minimis conſtitit Fixis.], 561.
  - disc-shaped bodies set in motion and impeded by another motion describe a curved path at every place [diſcea commota, atque ab alio Motu impedita, omni loco curvum deſignant iter.], 682.
  - disc-shaped bodies set in motion: when they are more and more impeded in their course, and depart from a straight track [diſcea commota, quando Curſu magis magisq; impediuntur, atque à recto tramite exorbitant.], 658.
  - disc-shaped bodies: why can they not move continuously in a circle? [diſcea,cur in orbem continuò moveri nequeant?], 570.
  - disc-shaped bodies gradually degenerate into a straight, or rather a conic, section [diſcea in rectam ſenſim, ſeu potiùs conicam degenerant ſectionem.], 570.
- Bodies: disc-shaped bodies, although an orbicular motion is impressed on them at the beginning with the greatest effort, can by no means preserve it [Corpora diſcea, licet Motus orbicus principiò eis ſummo ſtudio imprimatur, nullâ tamen ratione conſervare eundem posſunt.], 570.
  - disc-shaped bodies entirely reject circular motion [diſcea,Motum circularem planè reſpuunt.], 569.
  - disc-shaped bodies: by what motion they are moved [diſcea, quo Motu moventur.], 431.

- bodies of differing size and speed: in what way they are moved [diverſimodæ magnitudinis & velocitatis quâ ratione moventur.], 650.
- they are moved the more easily, the more they are able to, and the less they are impeded [eò moventur faciliùs, quò posſunt, atque minùs impediuntur.], 751.
- homogeneous bodies of entirely the same shape and size can be of differing power [homogenea ejusdem omninò Figuræ & Magnitudinis, diverſæ eſſe posſunt potentiæ.], 574.
- homogeneous bodies are carried toward one another by an inborn power [homogenea ex inſitâ virtute ad ſe invicem feruntur.], 645.
- all bodies of the world have their own atmospheres, in which various changes, alterations and generations occur [mundana omnia ſuas habent atmoſphæras, in quibus variæ mutationes, alterationes atque generationes accidunt.], 382.
- all bodies of the world give off expirations [mundana univerſa emittunt exſpirationes.], 380.
- all flat and upright bodies are carried continually in a straight line while the straight motion lasts; curved ones are carried obliquely [plana & erecta univerſa,durante motu recto,continuò in directum : Incurvata, in obliquum feruntur.], 581.

- Bodies: why do flat-shaped bodies incline more toward straight motion? [Corpora planiformia, cur ad motum magis propendeant rectum ?], 570.
  - thrown and fired bodies always advance with a parabolic motion [projecta & exploſa, motu ſemper progrediuntur parabolico.], 664.
  - thrown or falling bodies: why do they describe no straight motion, but always a parabolic one? [projecta vel decidentia, cur nullum deſignent motum rectum, ſed ſemper parabolicum ?], 664.
  - which bodies are more apt for motion [quænam ad motum magis ſunt apta.], 676.
  - which bodies are carried in straight lines [quænam in lineis feruntur rectis.], 562.
  - which bodies revolve in a circle [quænam in Orbem volvuntur.], 562.
  - the nearer they are to the Sun, the faster they are [quò Soli ſunt propiora, eò ſunt velociora.], 705.
  - spherical bodies, once driven in a circle: why do they continue the circular motion unceasingly, and cannot take on another? [ſphærica in Orbem ſemel acta, cur motum circularem indeſinenter proſequantur; nec alium asſumere posſint ?], 569.
  - more solid bodies are more apt for motion [ſolidiora ad motum ſunt aptiora.], 647.

    - thin and tapered bodies pass through a medium more easily than thicker and blunt ones [tenuia & faſtigiata faciliùs medium quoddam trajiciunt craſſioribus & obtuſis.], 571.
- Body: how the motion of any body is produced, propagated and preserved [Corporis alicujus motus quomodo procreatur, propagatur, & conſervatur.], 646.
    - the circumference and area of the cometary body of 1652 [cometici 1652 circumferentia,& area.], 334.
    - the nature of the cometary body [cometici Natura.], 649.
    - how the motion of a disciform body is retarded, twisted aside and accelerated again [diſciformis Motus quomodo retardatur, obtorquetur & rurſus acceleratur.], 571.
    - description of the lunar body [Lunaris Deſcriptio.], 362.
    - description of the solar body according to the Author's view [Solaris Deſcriptio ex mente Auctoris.], 359,360.
    - the rotation of the solar body produces the flow and ebb of that fiery sea [Solaris circumrotatio, fluxum & refluxum efficit Pelagi illius ignei.], 360.
- Bodies: ethereal bodies lose nothing, although they eject an immense quantity of exhalations [Corporibus æthereis nihil decedit, licet immane quantum exhalationum ejiciant.], 406.
    - all homogeneous bodies always have the quality of being carried toward one another and of tending to the same place [homogeneis omnibus, qualitas ſemper ineſt ad ſe invicem ferendi, atque in eundem locum tendendi.], 385.
- Bodies: ethereal bodies have the same manner of generation and corruption as terrestrial ones, though according to the quality of each body [Corporum æthereorum eadem datur, pro cujusvis tamen Corporis qualitate, generandi & corrumpendi ratio, quàm terrenorum.], 356.
    - the effluvia of ethereal bodies are joined and gathered more readily and more quickly in the south or the north [æthereorum effluvia proclivius, citiusq; in Auſtro aut Septentrione conjunguntur, & congregantur.], 717.
    - the manner in which ethereal bodies breathe out evaporations, according to the Author [æthereorum juxta Auctorem evaporationes exſpirandi modus.], 357.
    - the thicker evaporations of ethereal bodies remain in the atmosphere and revolve together with it [æthereorum Evaporationes craſſiores, in atmoſphærâ perſiſtunt, atque cum eâ ſimul circumgyrantur.], 382.
- Bodies: the finer expirations of ethereal bodies ascend even beyond the atmosphere [Corporum æthereorum exſpirationes ſubtiliores etiam ultra atmoſphæram aſcendunt.], 382.

- parts of ethereal bodies sometimes admit generation and corruption, but the whole is preserved forever [æthereorum partes nonnunquam Generationem & Corruptionem admittunt, totum verò in æternum conſervatur.], 394.
- the ancients counted the changes of ethereal bodies among absurdities [æthereorum vicisſitudines, Veteres inter abſurda retulerunt.], 381.
- the Aristotelians fear the dissipation of celestial bodies, but in vain [cœleſtium diffluxum Ariſtotelici metuunt, ſed fruſtrà.], 406.
- disciform bodies moving straight forward with their thinner side have greater power; inclined ones, by contrast, have less [diſciformium tenuiore latere rectà antrorsùm moventium major eſt potentia; Contrà, Inclinatorum minor.], 572.
- the motion of pyramid-shaped bodies is swifter when they are carried forward point first than when they are carried base first [pyramidatorum velocior motus eſt, quæ cuſpide,quàm quæ baſi antrorſum versùs feruntur.], 574.

- Body: an eternal body always preserves one and the same size [Corpus æternum unam ſemper eandemq́; conſervat magnitudinem.], 774.
  - every ethereal body has a singular power of preserving itself [æthereum omne ſingularem ſe conſervandi habet potentiam.], 382.
  - the cometary body turns one flat side toward its own body, from which it flowed out, and the other toward the Sun [cometicum, alterum latus planum corpori ſuo, ex quo profluxit, alterum Soli obvertit.], 649.
  - a faster cometary body imparts some of its speed to a slower one [cometicum celerius, ſegniori aliquid celeritatis confert.], 650.
  - it is more certain than certain that the cometary body is sometimes composed of various smaller corpuscles [cometicum ex variis minutioribus corpuſculis quandoq́ue componi, certò certius eſt.], 653.
  - a larger and faster cometary body carries a smaller one along with it [cometicum majus & velocius, minus ſecum fert.], 651.
  - a smaller cometary body is driven back in the opposite direction [cometicum minus in contrarium reflectitur.], 650.
- The cometary body: what is it like? [Corpus cometicum quale ?], 649.
  - the cometary body: in what way does it grow? [cometicum quâ ratione creſcat ?], 647.
  - a new cometary body: how it sets out on its path at the beginning [cometicum recens, quâ ratione iter ſuum initiò inſtituat.], 649.
  - a larger body in motion moves a smaller one at rest [commotum majus minus quieſcens movet.], 650.
  - a smaller body in motion is repelled by a larger one at rest [commotum minus, à quieſcente majori repellitur.], 650.

    - how far a body in motion has the power of persevering in its own motion [commotum quatenus vim habeat perſeverandi in ſuo motu.], 644.
- A pointed body, as regards motion, follows the nature of a wedge [Corpus cuſpidatum, quà motum, Naturam ſequitur cunei.], 575.
    - an inclined disc-shaped body is impeded and retarded by the medium it passes through [diſceum inclinatum, à medio quod trajicit, impeditur, & retardatur.], 573.
    - an extended body set in motion sometimes deflects from a straight track [extenſum commotumq́; nonnunquam à recto tramite deflectit.], 656.
    - the more an extended body is inclined at a right angle toward its course with either flat face, the more laboriously and slowly it moves [extenſum quò magis alterutrâ facie planâ curſum versùs inclinatur ad angulum rectum, eò ægrius tardiusq́; movetur.], 572.
    - a humped, or curved, body is not carried in a straight line [gibboſum, ſeu incurvatum non fertur in directum.], 585.
- A motionless body: from what cause it nevertheless seems to move [Corpus immobile, unde moveri nihilominùs videatur.], 638.
    - every oblong and flat-shaped body has its own natural rudder [oblongum & planiforme quodlibet, ſuum habet temonem naturalem.], 585.
    - an oblong or disc-shaped body, given a straight impulse, passes straight through air and through water alike [oblongum ſeu diſceum, dato impetu recto, pariter per aërem, ac per Aquam rectà trajicit.], 584.
    - every body moves with the motion with which it can be moved more readily [omne eo movetur motu, quo moveri poteſt procliviùs.], 570.
    - every body that is most strongly resisted, and against which a greater weight is set, moves with more difficulty and consequently also more slowly [omne, cui maximoperè reſiſtitur, majusq́; objicitur pondus, difficilius & per conſequens etiam tardius movetur.], 572.
- Every body is capable of motion and impetus [Corpus omne, eſt capax Motûs & Impetûs.], 644.
    - a flat-shaped body: does it continue without a break on a path once taken up, or does it rather turn aside from it gradually? [planiforme,an ſemel arreptum iter continuò proſequatur; an verò ſucceſſivè ab iſto deflectat ?], 576.
- Body: any flat-shaped body whatever, following a straight impulse, goes on continuously in an almost straight line [Corpus planiforme quodcunque, ſecundùm rectum impetum continuò rectà propemodùm pergit.], 585.

    - a projected body: how it moves from the point of separation [projectum à puncto ſeparationis quomodo moveatur.], 646.
    - a body projected, and separated from the motive power: how far, and for how long, it moves [projectum, & à virtute motrice ſeparatum; quousque, & quamdiu moveatur.], 646.
    - it is deduced by optical arguments that a pyramid-shaped body cuts any medium whatever more easily and more swiftly than a somewhat blunter one [pyramidatum, medium quodcunque leviùs velociusq; ſcindere, quodam obtuſiori, rationibus deducitur opticis.], 575.
    - in what way it moves with more difficulty or more slowly [quâ ratione difficiliùs tardiùsve moveatur.], 673.
- Body: in what way it is set in motion more easily and more swiftly [Corpus quâ ratione leviùs celeriusq; commoveatur.], 673.
    - every disc-shaped body imitates a ship fitted with a rudder [quodcunque diſceum, navem temone inſtructam æmulatur.], 585.
    - a certain body passes through the aether and the air more easily than through water [quoddam faciliùs per ætherem aêremq;, quàm per Aquam trajicit.], 584.
    - a body at rest in longitude nevertheless really moves [ſecundùm longitudinem quieſcens; reverà tamen movetur.], 638.
    - the solar body is subject to the greatest alterations and vicissitudes, beyond all the other bodies of the world [Solare alterationibus & vicisſitudinibus maximis eſt obnoxium [[;/,]] præ reliquis Corporibus mundanis omnibus.], 359.
    - it is demonstrated that a thin and pointed body can be moved more easily and more swiftly than a thicker and blunter one [tenue & cuſpidatum faciliùs velociusq; moveri poſſe,craſſiori atq; obtuſiori, demonſtratur.], 574.
- Corpuscles: that the corpuscles of which comets consist vary from day to day is proved by Cysat's observations [Corpuscula ex quibus Cometæ conſtant in dies variari, Cyſati Obſervationibus probatur.], 340.
- Corpuscles: those of which the cometary head consists vary perpetually, and shift their place in diverse ways [Corpuscula; ex quibus cometicum Caput conſtat, perpetuò variantur, Locoq; diverſimodè moventur.], 339.
- The variety of the corpuscles of the cometary head of 1618 [Corpusculorum Capitis cometici 1618 varietas.], 342.
- The greatest altitude of twilight [Crepusculi altitudo maxima.], 140.
- The manner of the course of haired stars [Crinitarum Stellarum cursûs ratio.], 646.
- Crüger's opinion on the motion of the comet of 1472 [Crügeri de motu Cometæ 1472 ſententia.], 605.

- The opinion of Crüger and of Kepler on Regiomontanus's method of computing parallaxes [Crûgeri, & Keppleri ſententia, de modo Regiomontani computandi parallaxes.], 296.
- Comets, even the most immoderate, do not reject a straight course [Curſum rectum, Cometæ, etiam immoderatisſimi, non reſpuunt.], 616.
- The course of comets: from what cause it is curved [Curſus Cometarum, unde incurvetur.], 678.
- The course of no comet can be correctly demonstrated in the air [Curſus Cometæ nullius in aëre demonſtrari rectè poteſt.], 591.
- The course of comets: when it is most impeded of all, and departs from its track [Curſus Cometarum quando omnium maximè impeditur, atque exorbitat.], 658.
- The genuine delineation of the course of the comet of 1652 [Curſus Cometici 1652 genuina delineatio.], 130.
- Wedges: the more acute they are, the greater their power [Cunei, quò ſunt acutiores, eò major eſt eorum potentia.], 574.
- The tip of comets: how far it can reach, and whether it can reach even the earth itself? [Cuſpis Cometarum quousque, & an ad ipſam etiam terram pertingere poſſit ?], 539.
- Bright tips of comets promise heads of comets more remote than the very ends of the tails [Cuſpides Cometarum ſplendidæ, capita Cometarum ipſis caudarum extremitatibus remotiora promittunt.], 539.
- Curvature does not occur without inclination of the tail, except in certain comets [Curvatura absque caudæ inclinatione non datur, niſi in quibusdam Cometis.], 497.
- Curvature of the tail: when it does not imitate the inclinations of the tail [Curvatura Caudæ, quando Inclinationes Caudæ non imitatur.], 505.
- Curvedness of the tail occurs, although the comet maintains its inclination, and the atmosphere different degrees of density and rarity [Curvitas Caudæ datur, licet Cometa inclinationem, & Atmoſphæra diverſos denſitatis & raritatis gradus obtineat.], 500.
- Real curvedness of the tail: in what way it is demonstrated [Curvitas Caudæ realis, quâ ratione demonſtratur.], 499.
- The new star in Cygnus: how long it lasted in the heavens [Cygni Stella nova, quamdiu in cœlo duraverit.], 381.
- Cysat's observations show the comet of 1618 as direct, although in reality it was retrograde [Cyſati Obſervationes Cometam 1618 directum oſtendunt, cùm tamen reverà retrogradus extiterit.], 625.
- Cysat's opinion on the bodies of comets [Cyſati ſententia de Cometarum corporibus.], 561.
- It is proved by Cysat that the corpuscles of which comets are composed vary from day to day [Cyſato probatur, corpuſcula ex quibus Cometæ componuntur, in dies variari.], 340.

- Cysat detected a vaporous orb around the Moon [Cyſatus circa Lunam, deprehendit Orbem vaporoſum.], 366.
- Cysat observed the comet of 1618 exquisitely [Cyſatus Cometam 1618 exquiſitè obſervavit.], 882.
- Cysat was mistaken in certain points concerning the comet of 1618 [Cyſatus in quibusdam circa Cometam 1618 hallucinatus eſt.], 625.

D.

- David Christiani's observation of the comet of 1652 [Davidis Chriſtiani Cometæ 1652 obſervatio.], 325.
- The declinations of the fixed stars have not yet been determined in every respect [Declinationes Fixarum nondum omnibus numeris ſunt determinatæ.], 209.
- Decreases and increases of the solar spots [Decrementa & Incrementa macularum Solarium.], 408.
- The proportion of the decreases and increases of motion is entirely different in each individual comet [Decrementorum & Incrementorum proportio motûs in ſingulis Cometis planè eſt diverſa.], 677.
- It is made clear by a delineation in what way the evaporations incline toward the Sun [Delineatione dilucidatur, quâ ratione evaporationes ſeſe ad Solem inclinent.], 421.
- A comet detected at the time of a solar eclipse [Deliquii Solaris tempore, Cometa detectus.], 808.
- A total eclipse of comets comes only from the shadow of the Earth and of the Moon [Deliquium totale Cometarum non niſi ab umbrâ Terræ & Lunæ provenit.], 552.
- Deflection of the tail: how it grows and decreases [Deflexio caudæ, quomodo creſcat, & decreſcat.], 568.
- The deflection of cometary tails from a straight line is proved by examples [Deflexio cometicarum caudarum à rectâ lineâ, exemplis probatur.], 484.
- Tycho thought that the deflection of the cometary tail was to be ascribed to Venus [Deflexionem caudæ cometicæ Veneri adſcribendam putavit Tycho.], 486.
- Cometary matter possesses different degrees of density and rarity [Denſitatis & raritatis diverſos gradus poſſidet Materia cometica.], 498.
- An accurate description of the comets of 1618 [Deſcriptio accurata Cometarum 1618.], 873.
    - of the second comet of 1618 [Cometæ ſecundi 1618.], 874.
    - of the third comet of 1618 [Cometæ tertii 1618.], 874.
    - the true description of comets according to the mind of the Author [vera Cometarum ex mente Auctoris.], 390.
- Effort must be spent so that Cometography too may be advanced more and more [Deſudandum eſt, ut quoque Cometographia plus plusq; promoveatur.], 353.
- God: how he operates [DEUS quomodo operatur.], 644.

- The deviation of the comet of 1661 from a great circle [Deviatio à circulo maximo Cometæ 1661.], 720,746.
    - does it always increase and decrease uniformly? [an æqualiter ſemper creſcat & decreſcat ?], 566.
    - is it entirely the same around the rising of comets and around their extinction? [an circa exortum Cometarum Interitumq; eorum omninò detur eadem ?], 565.
    - in which comets the apparent and the real deviation are detected together [apparens & realis in quibus Cometis ſimul deprehendatur.], 567.
    - the apparent deviation: in which comets it is detectable, while the real one is imperceptible [apparens, in quibus Cometis eſt deprehenſibilis; realis verò inſenſibilis.], 567.
    - the deviation of the tail: is it always equal, and how great is it? [caudæ, an æqualis ſemper,& quanta exiſtat ?], 485.
    - of the tail of the comet of 1577 [caudæ Cometæ 1577.], 489.
    - of the tail of the comet of 1590 [caudæ Cometæ 1590.], 489.
    - of the tail of the comet of 1618 [caudæ cometæ 1618.], 485, 489,624.
    - of the tail of the comet of 1647 [caudæ cometæ 1647.], 489.
    - of the tail of the comet of 1652 [caudæ cometæ 1652.], 464,489.
    - the greatest deviation of all of a cometary tail: how great is it? [caudæ cometicæ omnium maxima quanta ?], 486.
- The deviation of the cometary tail: Tycho too had an inkling of it, but did not know its cause [Deviatio caudæ cometicæ Tychoni etiam ſuboluit, ſed cauſam ignoravit.], 484.
    - of the cometary tails of 1661, 1664 and 1665 [caudarum cometicarum 1661,1664 & 1665[[./,]]], 775.
    - the apparent deviation of a comet: from what does it arise? [cometæ apparens, unde exoriatur ?], 567.
    - the real deviation of a comet: from what does it arise? [cometæ realis, unde exoriatur ?], 564.
    - the deviation of comets tends toward the Sun near the end [cometarum circa finem ad Solem tendit.], 667.
    - the deviation of comets at their first rising is sometimes carried the opposite way, away from the Sun [cometarum in primo exortu nonnunquam in contrarium à Sole fertur.], 667.
    - the greatest deviation of comets from the line of direction scarcely amounts to two degrees [cometarum maxima, à lineâ directionis vix duos adæquat gradus.], 684.
- The deviation of comets: can it be bound to fixed laws? [Deviatio cometarum, num ad certas leges adſtringi poſſit?], 489.
- The deviation of comets: when it increases [Deviatio Cometarum quando augetur.], 565.

    - the true and real deviation of a comet: where it takes its origin from [Cometæ vera & realis unde originem ſuam trahat.], 567.
    - when the one, as it were, eliminates the other [quando altera alteram quaſi eliminat.], 567.
    - in comets: when it is greatest [in Cometis, quando maxima.], 565.
    - in comets: when it is scarcely detectable [in Cometis, quando vix deprehenſibilis.], 564.
    - it is much more noticeable at the end than at the beginning of the appearance [in fine multò eſt notabilior, quàm initio apparitionis.], 565.
    - it seems to shed all uniformity [omnem æqualitatem exuere videtur.], 492.
    - of how many kinds it is [quotuplex.], 567.
- The true and the apparent deviation are not always detected together in all comets [Deviatio vera, & apparens ſimul non in omnibus Cometis ſemper deprehenditur.], 567.
- The deviations of the heads of comets must be carefully distinguished from the deviations of the tails [Deviationes capitum Cometarum, à deviationibus caudarum probè ſunt diſcernendæ.], 568.
    - the deviations of the tails are not yet bound to fixed laws [caudarum,certis nondum aſtringuntur legibus.], 776.
    - the deviations of cometary tails seem to take their origin from the latitudes [caudarum cometicarum, ex latitudinibus videntur ſuam trahere originem.], 490.
- With the deviation of the tails removed, no obliquity can be introduced into the tails [Deviatione caudarum remotâ, obliquitas caudis induci non poteſt.], 498.
- The Author examined the deviation of comets in the tail of 1577 [Deviationem Cometarum caudæ 1577 Auctor exploravit.], 487.
- It is shown from examples that the deviation is varied and unequal, yet sometimes subject to a reciprocating motion [Deviationem diverſimodam eſſe & inæqualem, motui tamen reciprocationis nonnunquam obnoxiam, exemplis deducitur.], 489.
- The deviations of various comets, collected in a table [Deviationes diverſorum Cometarum Tabulâ comprehenſæ.], 488.
- All comets are subject to deviation [Deviationi omnes Cometæ obnoxii ſunt.], 777.
- Comets are subject to a twofold real deviation [Deviationi duplici reali, Cometæ ſunt obnoxii.], 588.
- A notable example of the deviation of the tail [Deviationis caudæ exemplum notabile.], 555.
- The diversity of deviation is proved by examples [Deviationis diverſitas exemplis probatur.], 486.

- The apparent diameter of the Sun, viewed from the Earth and the planets [Diameter apparens Solis, ex Terrâ Planetisq; ſpectata.], 398.
- The apparent diameter of the Earth, seen from the planets [Diameter apparens Terræ, ex Planetis conſpecta.], 370, 398.
- The size of the apparent diameter of the comet of 1652, if the true diameter had always remained the same [Diametri apparentis quantitas Cometæ 1652, ſi vera ſemper eadem permanſisſet.], 347.
- The true diameter of the comet of 1618 and of 1652: how great it was [Diameter Cometæ 1618 & 1652 vera, quanta extiterit.], 562.
    - the apparent diameter of the comet of 1652 varied from day to day [Cometæ 1652 apparens in dies variata eſt.], 327.
    - the diameter of the comet of 1661 actually increased [Cometæ 1661 reapſe eſt aucta.], 774.
    - in certain comets the true and the visible diameter grow together [in quibusdam Cometis vera & viſa ſimul creſcit.], 346.
    - the apparent diameter of the Earth, seen from the planets [Terræ apparens ex Planetis conſpecta.], 370.
- The true size of the diameter of the comet of 1577 [Diametri vera magnitudo Cometæ 1577.], 858.
- The variation of cometary diameters proves that comets are by no means eternal bodies [Diametrorum cometicorum variatio evincit,Cometas minimè corpora eſſe æterna.], 774.
- The ratio of the diameters of the Sun, the Moon and the Earth according to various authors [Diametrorum Solis, Lunæ & Terræ juxta diverſos Auctores proportio.], 335.
- No comet has ever traversed the diameter of the great orb [Diametrum Orbis magni,nemo Cometarum unquam emenſus eſt.], 715.
- The transparent medium clinging behind the comet has different degrees of density [Diaphanum poſt Cometam hærens habet diverſos gradus denſitatis.], 500.
- The widening of the tails: how far it extends [Dilatatio caudarum, quousque extendatur.], 513.
- The widening and compression of the tails: from what cause? [Dilatatio & compreſſio caudarum unde ?], 508.
- Disc-shaped bodies set in motion: when they are more and more impeded in their course, and depart from the straight path [Diſcea corpora commota, quando curſu magis magisq; impediuntur, atque à recto tramite exorbitant.], 658.
    - disc-shaped bodies: why can they not move continuously in a circle? [corpora, cur in orbem continuò moveri nequeant ?], 570.
    - disc-shaped bodies entirely reject circular motion [corpora motum circularem omninò reſpuunt.], 569.
    - disc-shaped bodies: with what motion they move [corpora quo moveantur motu.], 431.

- In disc-shaped bodies a circular motion impressed on them gradually degenerates into a straight, or rather a conical, motion [Diſceis corporibus motus orbicus impreſſus degeneratur ſenſim in rectum, ſeu potiùs conicum.], 570.
- The disc-shaped comet: what is it? [Diſceus Cometa quis ?], 440.
- Among the disc-shaped comets, which is the principal one [Diſceos inter Cometas quinam primarius.], 439.
- One or the other flat side of the cometary disc faces the Sun in the same way as a magnetic needle faces the north [Diſci Cometici latus alterutrum planum, ſimili ratione Solem reſpicit, prout magnetica acus Septentrionem.], 667.
- Disc-formed bodies: why do they incline more toward straight motion? [Diſciformia corpora, cur ad motum magis propendeant rectum ?], 570.
- The power of disc-formed bodies moving straight forward with their thinner side is greater; that of inclined ones, by contrast, is less [Diſciformium corporum tenuiore latere rectà antrorſum moventium potentia major eſt; contra inclinatorum minor.], 572.
- Had its disc grown from day to day, the comet of 1652 would have disappeared much sooner [Diſco in dies creſcente, multò citiùs Cometa 1652 diſparuiſſet.], 347.
- The disagreement of certain authors concerning the perigee of the comet of 1664 [Diſconvenientia quorundam Auctorum ratione Perigæi Cometæ 1664.], 784.
- The disc of comets: is it always round? [Diſcus Cometarum, an ſemper ſit rotundus ?], 349.
- Distance: when it must be reduced to the orbit and to the vertical [Diſtantia ad orbitam,& verticalem, quando ſit reducenda.], 170, 171.
- The distance of the comet of 1652: how great it was near the end [Diſtantia Cometæ 1652, quanta fuerit circa finem?], 317.
- The genuine distance of comets cannot be known from the proportion of the intervals [Diſtantia Cometarum genuina, ex proportione Intervallorum cognoſci non poteſt.], 778.
- The distance of the comet of 1652 from the Earth has been amply demonstrated by the Author [Diſtantia Cometæ 1652 à Terrâ,abundè ſatis ab Auctore demonſtrata eſt.], 292.
- The distance of the companions of Saturn and Jupiter [Diſtantia comitum Saturni & Jovis.], 397.
- Distances are observed more accurately than azimuths [Diſtantiæ accuratiùs, quàm azimutha obſervantur[[,/.]]], 166.
- A distance parallel to the horizon is true and visible at the same time [Diſtantia horizontalis parallela, ſimul vera & viſa eſt.], 173.
- In how many ways distances are corrected [Diſtantiæ quot modis corriguntur.], 185.

- The new star in the neck of Cetus does not change its distance from the fixed stars [Diſtantiam ad Fixas, Stella nova in collo Ceti haud mutat.], 378.
- Distances are corrupted by reason of proper motion [Diſtantiæ ratione motûs proprii corrumpuntur.], 173.
- The difference of distances sometimes reveals the genuine parallax [Diſtantiarum differentia, nonnunquam detegit genuinam parallaxin.], 257.
- When there is no difference of distances, how to proceed in the parallactic calculation [Diſtantiarum differentia, quando nulla datur, quomodo procedendum in calculo parallactico.], 216.
- To free distances from all proper motion [Diſtantias ab omni motu proprio liberare.], 173.
- The distance of the Sun from the Earth [Diſtantia Solis à Terrâ.], 397.
- The different distance of the path from the Sun and from the Earth: can it introduce some diversity of motion? [Diſtantia Trajectoriæ à Sole Terrâq; diverſa, an diverſitatem aliquam motûs inducere poſſit ?], 693.
- The true distance: how it is found and corrected [Diſtantia vera, quâ ratione invenitur ac corrigitur.], 173.
- The direction of cometary tails extends according to the relative position of the Sun and the comet [Directio caudarum cometicarum, pro ratione ſitus Solis, & Cometæ protenditur.], 484.
- A method of investigating the direction and deviation of a cometary tail [Directionem & deviationem caudæ cometicæ inveſtigandi methodus.], 464.
- A certain deviation is present in the directions of cometary tails [Directionibus caudarum cometicarum deviatio quædam ineſt.], 484.
- The steering of a ship is the easier, the longer the tiller is [Directio navis eò eſt levior, quò clavus eſt longior.], 584.
- The scattering of the solar rays: how it happens in that rarer matter around the comet [Discuſſio radiorum Solarium, quâ ratione in materiâ illâ rariori circa Cometam accidat.], 483.
- The dissolution and generation of the solar spots [Diſſolutio, & generatio macularum Solarium.], 349.
- The first dissolution of comets: in which orb of the planets it takes place [Diſſolutio Cometarum prima, in quo Planetarum Orbe fiat.], 386.
- The distinction of comets [Diſtinctio Cometarum.], 439.
- Diversity: from what cause does so great a diversity appear in the face of comets? [Diverſitas, unde tanta in Cometaruɯ facie appareat ?] [recte: Cometarum], 418.
- The daily motion of the comet of 1652 along its own trace: how great it was [Diurnus motus Cometæ 1652 ſuper ſuo veſtigio, quantus fuerit.], 597.
- Why the duration of comets is unequal [Duratio Cometarum cur inæqualis ?], 345.

- The duration of eclipses of comets: can it be determined? [Duratio Eclipſium Cometarum, an definiri queat ?], 552.

E.

- A comet detected at the time of a solar eclipse [Eclipſeos Solaris tempore, Cometa detectus.], 450.
- At the time of a solar eclipse stars sometimes shine out [Eclipſeos Solaris tempore, nonnunquam Stellæ affulgent.], 363.
- Eclipses of comets: are they total and partial? [Eclipſes Cometarum, num totales & partiales ſint?], 552.
- Eclipses of comets: with what face they appear [Eclipſes Cometarum, quâ facie appareant.], 552.
- A total eclipse of a comet: does it occur? [Eclipſis Cometæ totalis, an detur ?], 552.
- An eclipse of the Sun in the time of Honorius [Eclipſis Solis, tempore Honorii.], 809.
- The duration of eclipses of comets: can it be determined? [Eclipſium Cometarum duratio, an definiri queat ?], 552.
- The plane of the ecliptic: do comets always cross it in the same way? [Eclipticæ planum, an Cometæ ſemper eâdem ratione trajiciant ?], 588.
- When the comet of 1572 crossed the ecliptic [Eclipticam, quando Cometa 1572 tranſierit.], 607.
- The effects and causes of many things, even sublunary ones, are unknown [Effectus & cauſæ multarum rerum etiam ſublunarium ignorantur.], 393.
- Effluvia, as parts of bodies, are of the same nature as the bodies themselves from which they flowed out [Effluvia corporum tanquam partes, ſunt ejusdem naturæ, ac ipſa corpora, ex quibus profluxére.], 657.
    - which effluvia are better suited to producing comets [quænam ad Cometas procreandos ſint aptiora.], 358.
- The motion of aetherial effluvia in their own atmosphere [Effluviorum æthereorum in ſuâ atmoſphærâ mot9.], 420.
- The end of effluvia and exhalations [Effluviorum & exhalationum finis.], 393.
- The elevation of the pole at Danzig [Elevatio Poli Dantiſcana.], 17.
    - the elevation of the pole at Paris [Poli Pariſienſis.], 155.
    - the elevation of the pole at Königsberg, corrected [Poli Regiomontana correcta.], 156.
- No being destroys itself, just as it does not produce itself either [Ens nullum ſe deſtruit, ſicuti nec ſe producit.], 648.
- The method of constructing the ephemeris of the comet of 1652 [Ephemeris Cometæ 1652 conſtructionis ratio.], 127.
    - the ephemeris of the comets of 1661, 1664, 1665, constructed by the Author from tangents [Cometarum 1661, 1664, 1665 ex Tangentibus, ab Auctore conſtructa.], 782.

    - the ephemeris constructed by the method of the Reverend Father Pardies from the Author's observations [Methodo R. P. Pardies,ex Auctoris obſervationibus conſtructa.], 781, 782.
    - the ephemeris of three comets observed by Peter Apian, constructed by the Author [trium Cometarum, à Petro Appiano obſervatorum, ab Auctore conſtructa.], 121.
    - the ephemeris of the true motion of the comet of 1652, for each day and its quarters [veri motus Cometæ 1652, ad ſingulos dies eorumq́; quadrantes.], 129, 130.
- The description and distinction of the equine comets [Equinorum Cometar.deſcriptio,& diſtinctio.], 440,442.
- An evident error: in what way it is noticed in deriving parallaxes [Error evidens, quâ ratione in eruendis parallaxibus animadvertitur.], 168.
- Aetherial evaporations: do they introduce any refraction? [Evaporationes æthereæ, num refractionem aliquam inducant ?], 406.
    - aetherial evaporations: how they are moved in their own atmosphere [æthereæ, quomodo in atmoſphærâ ſuâ commoveantur.], 644.
    - the subtler aetherial evaporations: in which part of comets they chiefly adhere [æthereæ ſubtiliores, quâ parte Cometis potisſimùm adhærent.], 478.
    - lunar evaporations are not so easily detected [Lunares non adeò facilè deprehenduntur.], 363.
    - lunar evaporations are much thinner than solar and terrestrial ones [Lunares, Solaribus & Terreſtribus multò ſunt tenuiores.], 363.
    - the evaporations of the planets, being outside the atmosphere, incline toward the Sun [Planetarum extra atmoſphæram exiſtentes, ad Solem ſe inclinant.], 420.
    - as long as evaporations remain in the atmosphere, they bend toward the body from which they came out [quamdiu in atmoſphærâ verſantur, ad corpus, ex quo prodiére, ſe inflectunt.], 657.
- Solar evaporations incline strongly toward condensation [Evaporationes Solares, ad condenſationem valdè propendent.], 385.
- Solar evaporations, as it were, glue together the outbreathings of the other planets [Evaporationes Solares, Planetarum reliquorum exſpirationes quaſi conglutinant.], 385.
- Aetherial exhalations sometimes produce particular meteors in the atmosphere [Exhalationes æthereæ, nonnunquam peculiaria Meteora in atmoſphærâ producunt.], 647.
- Celestial exhalations have a natural faculty of generation and of corruption [Exhalationes cœleſtes naturalem habent Generationis, & corruptionis facultatem.], 358.
- Exhalations and aetherial effluvia: in what way they flow out of bodies [Exhalationes & effluvia ætherea, quâ ratione ex corporibus effluant.], 357.

- The fixed stars too breathe out exhalations [Exhalationes etiam Fixæ exſpirant.], 373.
- The more solar exhalation a comet contains, the denser and more compact its body is conjectured to be [Exhalationis Solaris quantò plùs Cometæ ineſt, tantò denſius compactiusq́; eſſe corpus conjicitur.], 415.
- Exhalations of aetherial bodies: in what way they go out of those bodies, rise, and extend themselves [Exhalationum æthereorum corporum, quâ ratione ex corporibus iſtis exeant, aſcendant, atq́ue ſe ſe extendant.], 419.
- The end of the outbreathing of terrestrial exhalations into the atmosphere [Exhalationum terrenarum in atmoſphæram exſpirationis finis.], 356.
- The requisites of a comet's sudden rising [Exortûs Cometæ ſubitanei requiſita.], 710.
- More exact findings about comets: by what route they are obtained [Exquiſitiora in Cometis, quâ viâ obtineantur.], 778.
- The subtler outbreathings of aetherial bodies also rise beyond the atmosphere [Exſpirationes æthereorum corporum ſubtiliores, & ultra atmoſphæram aſcendunt.], 382.
- That thinner outbreathings occur around a comet is very probable [Exſpirationes circa Cometam dari tenuiores, valdè eſt probabile.], 482.
- The Sun breathes out incredible outbreathings in a single year [Exſpirationes incredibiles Sol uno anno exſpirat.], 403.
- The extremity of the cometary tail: when it is more remote than the head itself [Extremitas Caudæ cometicæ, quando remotior eſt ipſo capite.], 538.
- The extremity of the tail: when it appears blunter than it really is [Extremitas caudæ, quando obtuſior apparet, quàm reipsa exiſtit.], 539.

F.

- Cometary matter always presents a flat face toward the Sun and the Earth [Faciem perpetuò planam, Solem Terramq́; versùs materia cometica exponit.], 420.
- The differences of face of the three more recent comets [Facierum diverſitates recentiorum trium Cometarum.], 773.
- The face and form of the comet of 1618 [Facies, atq́ue forma Cometæ 1618.], 455.
    - the faces of the tails of comets: of how many kinds they are [Caudæ Cometarum, quotuplices ſint.], 437.
    - the face of a cometary tail grazing the Earth [Caudæ cometicæ Terram radentis.], 540.
    - the face of cometary tails varies wonderfully [Caudarum cometicarum mirificè variatur.], 508.
    - the face of a comet when the extremity of the tail is nearer the head [Cometæ, extremitate Caudæ capite vicinior exiſtente.], 536.
    - the face of the comet of 1618 detected by Wendelen with a tube [Cometæ 1618 à Wendelino tubo detecta.], 878.

    - the diverse face of the comet of 1652: where does it come from? [Cometæ 1652 diverſa unde ?], 537.
    - the face of the comet of 1652 will seem wonderful, indeed utterly absurd, to the Peripatetics [Cometæ 1652 Peripateticis mira, imò penitùs abſurda videbitur.], 323.
    - the face of the comet of 1652 detected with the telescope [Cometæ 1652 Teleſcopio detecta.], 326.
- The size of the faculae and of the solar spots relative to the Sun [Facularum, ac macularum Solarium magnitudo, reſpectu Solis.], 401.
- The Author observed remarkable faculae and shadows on the Sun [Faculas & umbras, Auctor in Sole conſpexit admirandas.], 478.
- A fiery torch falling from the sky [Fax ignea de cœlo cadens.], 818.
- Fienus's opinion on the tails of comets [Fieni ſententia, de Cometarum Caudis.], 472.
- The figure and colour of the comet of 1661 [Figura, atque color Cometæ 1661.], 220.
- The figure and form of comets [Figura atque forma Cometarum.], 418.
- The figure of the cometary body contributes a great deal to the motion of comets [Figura cometici corporis, motui Cometarum plurimùm confert.], 694.
- The figure and length of the cometary shadow [Figura Umbræ cometicæ, & longitudo.], 545.
- A fissure in the middle of the tail: when it is seen [Fisſura in medio Caudæ, quando conſpicitur.], 518.
- Some fixed stars perish only in appearance [Fixæ nonnullæ apparenter tantummodò pereunt.], 381.
    - some fixed stars have changed not a little up to now [nonnullæ haud parùm huc usque ſunt mutatæ.], 381.
    - new fixed stars: why do they have no tails? [novæ, cur nullas habeant Caudas ?], 556.
    - new fixed stars always twinkle [novæ ſemper corruſcant.], 433.
    - if all the fixed stars detectable with the naked eye were observed correctly, it would greatly benefit astronomy [omnes nudis oculis deprehenſibiles, ſi rectè obſervarentur,rei Aſtronomicæ valdè conduceret.], 400.
- The fixed stars: with what speed, according to the Peripatetics, they are carried by the common motion [Fixæ, quantâ velocitate, juxta Peripateticos motu communi feruntur.], 707.
    - the fixed stars: in what way they are produced [quâ ratione producuntur.], 422.
    - the fixed stars can sometimes vary in size and vanish completely [quoad magnitudinem variari, ac penitùs evanescere nonnunquam posſunt.], 381.

- The fixed stars too breathe out evaporations and exhalations [Fixæ quoque evaporationes, & exhalationes exſpirant.], 373.
    - the fixed stars, if they moved in orbs: would they introduce a parallax? [ſi moverentur in orbibus, an parallaxin inducerent ?], 423.
- A fixed star: the farther it is from the orbit of comets, the more its true place also differs from its visible place [Fixa, quò magis ab orbitâ Cometarum removetur, eò magis verus etiam à viſo loco differt.], 184.
- The shadowing of the fixed stars by the shadow of the planets is rare [Fixarum inumbratio, ab umbrâ Planetarum rara.], 550.
    - more accurate places of the fixed stars are required for deriving parallaxes [loca accuratiora requiruntur, ad parallaxes eruendas.], 209.
    - that some fixed stars have changed in magnitude is proven by examples and observations [nonnullas, quà magnitudinem immutatas eſſe; exemplis & obſervationibus probatur.], 400.
    - the Author, with God, has undertaken to compile a new catalogue of the fixed stars [novum Catalogum condere, Auctor, cum DEO, ſuſcepit.], 400.
    - the position of certain fixed stars with respect to the ecliptic for the year 1661 [quarundam Situs, quà Eclipticam ad an. 1661.], 731.
    - the twinkling of the fixed stars: where does it come from? [ſcintillatio unde ?], 373.
    - the size of the sphere of the fixed stars: how great it is [Sphæræ amplitudo,quanta extet.], 714.
    - a certain and accurate number of the fixed stars has not yet been determined [Stellarum certus & accuratus numerus, nondum eſt determinatus.], 400.
    - very many of the fixed stars have so far not yet been observed by the ancients [Stellarum plurimæ,à Veteribus hactenus nondum ſunt obſervatæ.], 400.
    - the speed of the fixed stars according to the Peripatetics: how great is it? [velocitas juxta Peripateticos quanta ?], 707.
- That very many new fixed stars arise in the course of time is not so very contrary to reason [Fixas Stellas novas tractu temporis perplures exoriri, rationi non adeò contrarium.], 406.
- The more a fan is unfolded and spread out, the more vigorous the breeze it raises, and the harder it is to move [Flabellum quò magis eſt explicatum, expanſumq;, eò vehementiorem excitat auram, ægriusq; commovetur.], 675.
- The fluctuation of the tail of the comet of 1618: how far it spread [Fluctuatio Caudæ Cometæ 1618, quousque ſeſe dilataverit.], 518.
- The fluctuation of tails: when it becomes more noticeable and more inconstant than usual [Fluctuatio Caudarum, quando redditur notabilior, & inconſtantior ſolitò.], 513.

- The sudden fluctuation of comets is demonstrated by various comets [Fluctuatio Cometarum ſubitanea, demonſtratur Cometis diverſis.], 509.
- The fluctuations and leapings of tails are not always the same [Fluctuationes & ſubſultationes Caudarum non ſunt ſemper eædem.], 512.
- The true explanation of the fluctuation and vibration of tails [Fluctuationis,& Vibrationis Caudarum vera ratio.], 510.
- The form, light and colour of the comet of 1618 [Forma, lumen atque color Cometæ 1618.], 455.
- Fortunio Liceti's opinion on the matter of the cometary tail [Fortunii Liceti opinio de materiâ Caudæ cometicæ.], 472.
- Fortunio Liceti asserts that the head of a comet consists of very many little stars [Fortunius Licetus caput Cometæ ex plurimis conſtare ſtellulis aſſerit.], 472.
- Froidmont's opinion on the matter of the cometary tail [Fromondi opinio de materiâ Caudæ cometicæ.], 472.
- Fracastoro's view on the direction of tails [Fracaſtorii de directione Caudarum ſententia.], 461.
- Fracastoro also correctly detected the directions of the tail [Fracaſtorius directiones Caudæ etiam probè deprehendit.], 847.
- The opinion of Franciscus Resta and Camillus Gloriosus on the matter of the cometary tail [Franciſci Reſtæ, & Camilli Glorioſi opinio de materiâ Caudæ cometicæ.], 472.
- A most brilliant comet [Fulgentiſſimus Cometa.], 798,819,821,827,833,842.
- Fullenius's observations of the new star in the neck of Cetus [Fullenii de novâ Stellâ in collo Ceti obſervationes.], 377.
- The nature of the sling, with respect to projection [Fundæ natura, ratione projectionis.], 645.

G.

- García de Silva y Figueroa observed a comet in Persia in the year 1618 [Garcias Silva Figuroës in Perſiâ Cometam anno 1618 obſervavit.], 875.
- The judgement of Gassendi and Cardano on astrological matters [Gaſſendi, & Cardani de rebus Aſtrologicis judicium.], 428.
    - Gassendi's view on the tails of comets [ſententia, de caudis Cometarum.], 472.
- The observations of Gemma Frisius and Cornelius Gemma on the direction of tails [Gemmæ & Cornelii Friſiorum, de directione caudarum obſervationes.], 461.
- The view of Gemma Frisius and others on the generation of tails [Gemmæ Friſii, & aliorum de generatione caudarum ſententia.], 470.
- The method of generating comets [Generandi Cometarum ratio.], 383,434.
- The generation of tails: in what way it comes about [Generatio caudarum, quâ ratione accidat.], 476.

- There is no generation of a comet in the air [Generatio Cometæ in aêre nulla.], 319.
- The generation of comets does not hinder the planets [Generatio Cometarum, Planetis non officit.], 436.
- Generation and corruption are perpetual around the aetherial bodies, as they are around the Earth [Generatio & corruptio circa corpora ætherea, ut circa Terram perpetua eſt.], 394.
- There is no generation and corruption of comets in the air [Generatio & corruptio Cometarum non datur in aêre.], 612.
- Generation and corruption of comets occur throughout the whole aether [Generatio & corruptio Cometarum per totum datur ætherem.], 435.
- The generation and dissolution of the solar spots [Generatio & disſolutio macularum Solarium.], 349,411.
- How the heavens are subject to generation and corruption [Generationi & corruptioni, quomodo cœlum eſt obnoxium.], 355.
- A humped or curved body is not carried in a straight line [Gibboſum corpus ſeu incurvatum non fertur in directum.], 585.
- The hump of a curved tail: does it always stand in the middle? [Gibbus caudæ incurvatæ, an in medio perpetuò conſiſtat ?], 506.
- The remarkable size, circumference and surface of the cometary globe of 1652 [Globi cometici 1652 admiranda magnitudo, circumferentia, & ſuperficies.], 334.
- All celestial globes have a vaporous orb [Globos cœleſtes univerſos, Orbem habent vaporoſum.], 371.
- That a globe that has been shot describes a parabolic line: how is it established? [Globum exploſum, lineam deſcribere parabolicam, unde conſtet ?], 660.
- Every aetherial globe has various innate qualities [Globus æthereus quilibet, varias habet innatas qualitates.], 393.
    - a globe shot from a cannon: along what line it is carried [è tormento exploſus, quâ feratur lineâ.], 659.
- Graminæus's observations of the comet of 1580 [Graminæi obſervationes Cometæ 1580.], 860.
- The gravity of a thing: what it is [Gravitas rei, quid ſit.], 662.
- Everything expanded also has a centre of gravity [Gravitatis centro omne expanſum etiam gaudet.], 420.
- The difference between heavy bodies descending and bodies projected by violent motion [Gravium deſcendentium, & Trajectorum ex motu violento differentia.], 573.
- Grimaldi's view on the appearances of tails [Grimaldi, de caudarum apparentiis ſententia.], 473.
- How rudders steer and direct ships [Gubernacula,quo pacto Navigia regant ac dirigant.], 577, 578.

H.

- Hájek's observation of the comet of 1580 [Haggecii obſervatio Cometæ 1580.], 860.
- Hájek erred concerning the motion of the comet of 1580 [Haggecius circa motum Cometæ 1580 aberravit.], 862.
- The breaths of each planet leave its sphere, or its own orb, only with difficulty [Halitus, cujusq; Planetæ Sphæram, ſeu orbem ſuum ægrè deſerunt.], 385.
- The Prince of Hesse's observation of the comet of 1558 [Hasſiaci Principis obſervatio Cometæ 1558.], 854.
- The Prince of Hesse's observation of the comet of 1585 [Hasſiaci Principis obſervatio Cometæ 1585.], 868.
- A spear-shaped comet [Haſtiformis Cometa.], 448.
- What the hemisphere of the Sun is [Hemiſphærium Solis quid ſit.], 593.
- The Hircus [Hircus.], 440, 799.
- A hairy comet changed into the shape of a spear [Hirſutus Cometa in formam haſtæ mutatus.], 797.
- How a hairy comet acquires a beard [Hirſutus Cometa quomodo barbam acquirit.], 526.
- The description of the comet of Jerusalem [Hieroſolymitani Cometæ deſcriptio.], 446.
- The comet of Jerusalem: was it a portent, or rather a genuine comet? [Hieroſolymitanus Cometa, an oſtentum, an verò genuinus Cometa fuerit ?], 712.
- Kepler wrote a history of the comet of 1607 [Hiſtoriam Cometæ 1607 Keplerus conſcripſit.], 622.
- For what purpose the Author wrote the history of comets, and what he chiefly attended to in it [Hiſtoriam Cometarum quem in finem Auctor conſcripſerit, & quænam in illâ præcipuè attenderit.], 791,792.
- Hommel's observation of the comet of 1556 [Hommelii obſervatio Cometæ 1556.], 850.
- The discrepancy, in the comet of 1661, between the hypothesis constructed from tangents and the observations taken from the sky itself [Hypotheſeos ex tangentibus conſtructæ,& obſervationum ex ipſo cœlo petitarum in Cometâ 1661 diſcrepantia.], 783.
    - the deviation of the hypothesis from tangents: where it arises from [ex tangentibus deviatio, unde oriatur.], 787.
- The departure from the truth of the hypothesis by tangents is not to be laid on the observations [Hypotheſeos per tangentes à vero aberratio, non in obſervationes eſt rejicienda.], 783.
- A remedy can be brought to the hypothesis from tangents in part, but not in every part [Hypotheſi ex tangentibus, medela ex parte, ſed non ab omni parte afferri poteſt.], 786.
    - that the hypothesis from tangents can to some extent be helped by the motion of the nodes is demonstrated by the three later comets

[ex tangentibus,motu Nodorum quadantenus ſubveniri poſſe, tribus Cometis poſterioribus demonſtratur.], 787, 788, 789.
- The motion of the nodes stands very much in the way of the hypothesis from tangents [Hypotheſi ex tangentibus,motus nodorum maximè obſtat.], 787.
- How the hypothesis from tangents can be helped, according to the Author's mind [Hypotheſi ex tangentibus, quâ ratione ex Auctoris mente ſubveniri poſſit.], 783.
- The hypothesis of a certain fictitious comet, visible for a whole year [Hypotheſis alicujus Cometæ ficti, toto anno conſpicui.], 636.
    - the Author's hypothesis sustains all the appearances in comets [Auctoris,omnes apparentias in Cometis ſuſtinet.], 343.
    - the Author's hypothesis, and the position of the path, is likewise established from the calculation of the comet of 1665 [Auctoris,ſitusq́; Trajectoriæ, ex calculo Cometæ 1665 pariter ſtabilitur.], 770.
- The hypothesis of the comet of 1472 [Hypotheſis Cometæ 1472.], 604.
    - of the comet of 1577 [cometæ 1577.], 616.
    - of the comet of 1531 [cometæ 1531.], 613.
    - of the comet of 1585 [cometæ 1585.], 620.
    - of the comet of 1590 [cometæ 1590.], 620.
    - of the comet of 1618 [cometæ 1618.], 627.
    - of the comet of 1652 [cometæ 1652.], 594.
    - of the comet of 1661 [cometæ 1661.], 746.
    - of the comet of 1664 [cometæ 1664.], 760.
- The hypothesis of the comet of 1665 [Hypotheſis cometæ 1665.], 768.
- The hypothesis from tangents is very unsteady [Hypotheſis ex tangentibus admodùm vacillat.], 786.
    - the hypothesis constructed from tangents: does it correspond so accurately to the observations themselves, as some are persuaded? [ex tangentibus conſtructa, an adeò accuratè ipſis obſervationibus reſpondeat ? ut quibusdam eſt perſuaſum.], 780.
- The hypothesis of a certain wonderful comet [Hypotheſis mirifici cujusdam Cometæ.], 634.
- The hypothesis for the generation of new stars [Hypotheſis pro Generatione novarum Stellarum.], 423.

I.

- An explanation of the figures representing the curvedness of the tail [Iconiſmorum elucidatio repræſentantium curvitatem caudæ.], 499.
- A fiery comet like a wheel [Igneus Cometa inſtar Rotæ.], 795,796.
- Elemental fire is to be sought in the Sun [Ignis elementaris in Sole quærendus.], 359.
- Given an impetus, a parabolic motion results [Impetu dato, datur motus parabolicus.], 663.

- The first impetus in comets: how it is produced [Impetus in Cometis primus,quomodo producitur.], 645.
- Impressed motion is gradually weakened [Impreſſus motus paullatim debilitatur.], 662.
- Inclination, apparent and real [Inclinatio apparens, & realis.], 655.
    - the inclination of the cometary head: in what way it comes about with respect to the path [Capitis cometici, quâ ratione reſpectu Trajectoriæ fiat.], 656.
    - the inclination of the disc does the same in comets as gravity does in a globe that has been shot or projected [diſci, idem in Cometis operatur, quod in globo exploſo, vel projecto gravitas.], 667.
    - the inclination of the disc: when there is none [diſci, quando nulla datur.], 686.
    - what the inclination of the disc is [diſci quid ſit.], 656.
- When the inclination of the tail is given, a curving is not given at the same time [Inclinatione caudæ datâ, non ſimul datur incurvatio.], 498.
    - as the inclination of the disc decreases, the motion of comets increases [diſci decreſcente, motus Cometarum augetur.], 672.
- The inclination of the orbit and of the nodes of comets is variable and mobile [Inclinatio orbitæ, atque Nodorum Cometarum variabilis, ac mobilis eſt.], 122, 123.
    - the inclination of the orbit does not bear out a wandering motion in comets [Orbitæ, vagum motum Cometis haud probat.], 134.
- That the inclination of the disc varies unceasingly is shown by a diagram [Inclinationem diſci indefinenter variari, Schemate declaratur.], 670.
- The angle of inclination of the planets [Inclinationis angulus Planetarum.], 134.
- The motion of inclination of the tails has been found in certain comets to be, as it were, reciprocating [Inclinationis motus caudarum, in quibusdam Cometis quaſi reciprocus deprehenſus eſt.], 492.
- The inclination of the path in the comet of 1661 was variable [Inclinatio Trajectoriæ in Cometâ 1661 variabilis extitit.], 747.
- The inclination of the path of 1664 [Inclinatio Trajectoriæ 1664.], 759.
- The proportion of the increases and decreases of motion is entirely different in each individual comet [Incrementorum & decrementorum proportio motûs,in ſingulis Cometis planè eſt diverſa.], 677.
- In certain comets the increases of motion follow the variation of the comet's motion from the Sun [Incrementa motûs, in quibusdam Cometis variationem motûs Cometæ ex Sole ſequuntur.], 692.
- The curving of the cometary tail of 1618 [Incurvatio caudæ cometicæ 1618.], 494.
    - the curving of the tail: toward which quarter it proceeds [caudæ, quam plagam versùs procedat.], 501.

    - the curving of the tail occurs in every direction [caudæ,quaquaverſum exiſtit.], 505.
    - the curving of cometary tails is real [caudarum cometicarum eſt realis.], 494.
- The curving of tails by straight rays is made clear by a figure [Incurvatio caudarum per rectos radios, Iconiſmo elucicidatur.] [recte: elucidatur], 495.
- The curving of tails: how great the greatest of all is, according to the Author [Incurvatio caudarum, quanta ſit omnium maxima juxta Auctorem.], 505.
- The curving of comets: from what cause? [Incurvatio Cometarum unde ?], 493.
- The curving follows the course of the inclination [Incurvatio inclinationis ductum ſequitur.], 503.
- To get to the bottom of the curvings of tails is hard [Incurvationes caudarum penetrare, arduum eſt.], 495.
- Some lay the cause of the curving of tails on refraction [Incurvationis caudarum cauſam,nonnulli in refractionem rejiciunt.], 494.
- The curving of the path is known from the angle of obliquity [Incurvatio Trajectoriæ,ex angulo cognoſcitur obliquitatis.], 750.
    - the curving of the path: in which comets it mostly occurs [Trajectoriæ, in quibus Cometis plerumque accidat.], 770.
    - the greatest curving of the path: when it occurs [Trajectoriæ maxima, quando contingat.], 770.
    - the curving of the path is not always the same in all comets [Trajectoriæ, non ſemper in omnibus Cometis eſt eadem.], 770.
- The inflection of comets: does it appear equal in comets at every time? [Inflexio Cometarum, an omni tempore æqualis in Cometis appareat ?], 505.
- A remarkable splendour formed into the figure of a cross [Inſignis ſplendor in figuram crucis efformatus.], 827.
- The instruments with which the comet of the year 1652 was observed [Inſtrumenta, quibus Cometa anni 1652 fuit obſervatus.], 5.
- The intervals of the planets according to the Author's hypothesis, set out in a little table [Intervalla Planetarum ſecundùm Auctoris hypotheſin in Tabellâ exhibita.], 713.
- The difference in a comet's interval from the Sun contributes nothing either to its motion or to the increase of its speed [Intervalli Cometæ à Sole differentia, nec motui, nec incremento velocitatis quicquam confert[[./,]]], 693.
- To investigate the interval of comets from the Earth is very hard and difficult [Intervallum Cometarum à Terrâ explorare, admodùm arduum, & difficile eſt.], 744.

- The interval of the comet of 1589 from the Earth [Intervallum Cometæ à Terrâ 1589.], 620.
    - of the comet of 1664 from the Earth [cometæ 1664 à terrâ.], 758,765.
    - of the comet of 1664 from the Sun [cometæ 1664 à Sole.], 766.
    - of the comet of 1665 from the Sun [cometæ 1665 à Sole.], 772.
- The interval of comets from the Earth is entirely unknown from the theory of tangents [Intervallum Cometarum à Terrâ, ex Theoriâ Tangentium planè ignoratur.], 750.
- The interval of the perpendicular from the comet to the Earth: how it is investigated [Intervallum perpendiculi ex Cometâ à Terrâ, quomodo exploratur.], 598.
- The interval of the Sun from the Earth according to the Author [Intervallum Solis à Terrâ ſecundùm Auctorem.], 702.
    - of the Sun from the Earth according to Riccioli [Solis à Terrâ ſecundùm Ricciolum.], 702.
    - of the Sun from the Earth according to Wendelen [Solis à Terrâ ſecundùm Wendelinum.], 702.
    - of the Sun from the Earth according to Kepler [Solis à Terrâ ſecundùm Keplerum.], 702.
    - that the true interval of a comet from the Earth can in no way be correctly determined by tangents, even the distinguished Petit admits [verum Cometæ à Terrâ,per tangentes rectè nullo modo definiri poſſe,etiam Cl.Petitus fatetur.], 777.
- The shadowings of comets are made clear by a diagram [Inumbrationes Cometarum Schemate elucidantur.], 554.
- The shadowing of planets and of comets: how they differ [Inumbratio Planetarum & Cometarum, quomodo differant.], 549, 553.
- The shadowing of the stars by the shadow of the planets is rare [Inumbratio Stellarum, ab umbrâ Planetarum rara.], 549.
- The Jovian spots, zones and bands [Joviales Maculæ, Zonæ & Faſciæ.], 371.
- The spots of the Jovials: what they are [Jovialium Maculæ quid ſint.], 371.
- The colour of the spots of the Jovials [Jovialium Macularum color.], 371.
- A description of the spots of the Jovials [Jovialium Macularum deſcriptio.], 371.
- The size of the Jovials [Jovialium magnitudo.], 394,397.
- That Jupiter is subject to far greater changes than our earth is very probable [Jovem mutationibus longè majoribus, quàm terram noſtram eſſe obnoxium,valdè eſt veroſimile.], 398.
- The apparent size of the atmospheres of Jupiter and Saturn [Jovis, atque Saturni Atmoſphærarum magnitudo apparens.], 387.
- The companions of Jupiter and Saturn exert very great forces in thrusting out exhalations [Jovis, atque Saturni Comites, maximas vires exerunt, in extrudendis exhalationibus.], 371.

- The size of the companions of Jupiter as seen from Jupiter [Jovis Comitum ex Jove conſpectorum magnitudo.], 398.
- The companions of Jupiter and Saturn are like moons [Jovis, & Saturni Comites, ſunt inſtar Lunarum.], 371.
- The operation of the companions of Jupiter and Saturn [Jovis & Saturni Comitum operatio.], 371.
- The satellites of Jupiter: why do they appear now larger, now smaller? [Jovis Satellites, cur modò majores, modò minores appareant ?], 370.
- The sizes of the companions of Jupiter and Saturn, according to Kepler's hypothesis as well as ours [Jovis Saturniq́; Comitum magnitudines, tàm ſecundùm Kepleri, quàm noſtram hypotheſin.], 397.
- The judgement of Cardano and of Gassendi on astrological matters [Judicium Cardani, & Gaſſendi de rebus Aſtrologicis.], 428.
- An absolute judgement about comets: to whom it belongs [Judicium de Cometis abſolutum,quibus competat.], 318.
- A comet appeared in the time of Julius Caesar [Julii Cæſaris tempore Cometa apparuit.], 802.

K.

- Kepler's advice for those slower of wit in astronomical matters [Kepleri Conſilium pro hebetioribus in re Aſtronomicâ.], 318.
- Kepler's opinion on the tails of comets [Kepleri de Cometarum caudis ſententia.], 470.
- Kepler's opinion on the motion of comets, and in particular on the comet of 1472 [Kepleri, de motu Cometarum, & in ſpecie de Cometâ 1472 ſententia.], 605.
- The opinion of Kepler and of Crüger on Regiomontanus's method of computing parallaxes [Kepleri, & Crügeri ſententia de methodo Regiomontani ſupputandi parallaxes.], 296.
- Kepler's interval of the Sun from the Earth [Kepleri Intervallum Solis à Terrâ.], 702.
- Kepler's observation of the comet of 1607 [Kepleri obſervatio Cometæ 1607.], 871.
- Kepler's opinion on the angle of inclination, contrary to Crüger's [Kepleri ſententia de angulo inclinationis, Crûgeri contraria.], 117.
- Kepler's singular opinion on the matter of cometary tails [Kepleri ſingularis ſententia, de materiâ caudarum cometicarum.], 471.
- Kepler's theorems on the motion and trajection of comets are not universal, nor do they hit the mark on every point [Kepleri Theoremata, de motu & trajectione Cometarum, non ſunt univerſalia, nec omnem rem acu tangunt.], 641,642.
- For Kepler and Wendelen the parallax of the comet of 1618 was imperceptible [Keplero & Wendelino parallaxis Cometæ 1618 fuit inſenſibilis.], 878.

- Kepler doubts that as much matter can be present around comets as would be required for the longest tails [Keplerus diffidit, tantùm materiæ circa Cometas dari poſſe, quantùm quidem ad longiſſimas caudas requiratur.], 481.
- Kepler wrote a history of the comet of 1607 [Keplerus Hiſtoriam Cometæ 1607 conſcripſit.], 622.
- Kepler was the first who tried to save the comets of 1607 and 1618 by straight lines [Keplerus primus fuit, qui Cometas 1607 & 1618 per lineas rectas ſalvari conatus eſt.], 591.
- The judgement of Kircher and Scheiner on the atmosphere of the Moon [Kircheri & Scheineri Judicium, de Atmoſphærâ Lunæ.], 366.
- Kircher's opinion on the wonderful body of the Sun [Kircheri ſententia, de admirando Solis corpore.], 360.

L.

- How stones fall from a tower, given a daily motion of the earth [Lapides quâ ratione de Turri decidunt, dato motu telluris diurno.], 665.
- How a stone thrown straight up behaves in a moving ship [Lapis ad perpendiculum projectus, quâ ratione in navi commotâ ſe habet.], 663.
- Why does a projected stone tend toward the centre? [Lapis projectus, cur ad centrum vergat ?], 654.
- Whether a stone is thrown by a power at rest or by a power in motion, it will nevertheless always fall back to the same place [Lapis, ſive à quieſcente, ſive à commotâ potentiâ projiciatur, in eundem tamen ſemper locum decidet.], 664.
- The fall of falling bodies and an impressed lateral motion: how they differ [Lapſus rerum cadentium, & motus impreſſus lateralis, quomodo differant.], 573.
- Leovitius's observation of the comet of 1556 [Leovitii Obſervatio Cometæ 1556.], 851.
- A clear libration in the solar spots [Libratio evidens in Maculis Solaribus.], 566.
- In comets, libration of an entirely different kind occurs [Libratio in Cometis omninò datur diverſa.], 710.
- Libration: when does it increase, and decrease again? [Libratio, quando creſcit, rurſusq; decreſcit ?], 709.
- Libration: when it passes from east to west [Libratio, quando ex Ortu ad Occaſum migrat.], 709.
- The libratory motion of comets varies with their varying position relative to the Sun and the Earth [Libratorius motus Cometarum,pro vario ſitu ad Solem Terramq; variatur.], 709.
- Limitation through the motion of the nodes: in which comets does it take place? [Limitatio per motum Nodorum,in quibus Cometis habet locum ?], 789.

- Perpendicular lines are stronger in resisting than more oblique ones [Lineæ perpendiculares, validiores ad renitendum ſunt obliquioribus.], 575.
- Lines of sight: when they intersect one another, and when they diverge again [Lineæ viſoriæ, quando ſeſe interſecant, & quando rursùs divaricantur.], 638.
- The line in which comets begin and complete their course: of what kind is it? [Linea,in quâ Cometæ curſum ſuum inſtituunt &abſolvunt, cujus ſit generis ?], 659.
- The line of motion of globes is not simply inclined [Linea motus globorum non ſimpliciter eſt inclinata.], 660.
- The perpendicular line is the shortest of all [Linea perpendicularis, omnium eſt brevisſima.], 176.
- The spiral line: is it exactly the same in all comets? [Linea ſpiralis, an in omnibus Cometis planè ſit eadem ?], 670.
- To determine the genuine place of any comet is hard [Locum cujusvis Cometæ explorare genuinum, arduum eſt.], 314.
- The true place of a comet and its distance from the earth are sought in vain without the parallax [Locus Cometæ verus & à terrâ diſtantia, absque parallaxi fruſtrà inveſtigantur.], 138.
- A method of determining the true length of tails [Longitudinem caudarum veram explorandi methodus.], 520.
- How great the apparent length of the longest tail is, at a distance of the comet from the Earth of 100 semidiameters of the Earth [Longitudo apparens caudæ longisſimæ, in diſtantiâ Cometæ à Terrâ 100. Semid. T. quanta.], 528.
- The apparent length of the tail varies very greatly with the varying digression of the comet from the Sun [Longitudo apparens caudæ, pro variâ digreſſione Cometæ à Sole maximè variatur.], 524.
- The true length of the cometary tail: how it grows [Longitudo caudæ cometicæ vera,quomodo creſcit.], 524.
- The true length of the tail: why does it vary? [Longitudo caudæ vera, cur varietur ?], 524.
- The true length of the tail of the comet of 1618 [Longitudo caudæ vera Cometæ 1618.], 520.
- The true length of the tail of the comet of 1652 [Longitudo caudæ vera Cometæ 1652.], 520.
- The true length of the tail of the comet of 1652: how it differed from the apparent length [Longitudo vera caudæ Cometæ 1652,quomodo variaverit ab apparente longitudine.], 524.
- The true length of all tails cannot be determined, for lack of observations [Longitudo vera omnium caudarum, ex defectu obſervationum explorari non datur.], 519.

- The length of the shadow of any planet, the Moon excepted, is far less than the interval even of the nearer planets [Longitudo umbræ cujuscunque Planetæ, exceptâ Lunâ, longè eſt minor, quàm intervallum viciniorum etiam Planetarum.], 550.
- Longomontanus's observation of the comet of 1607 [Longomontani Obſervatio Cometæ 1607.], 872.
- Longomontanus's observation of the comet of 1618 [Longomontani Obſervatio Cometæ 1618.], 879.
- A very bright comet, larger than Venus [Lucidisſimus Cometa,major Venere.], 806.
- Luculae: in what way are they brought into lunar eclipses? [Luculæ, in Ecclipſes Lunares quâ ratione inducantur ?], 365.
- The proportion of the luminaries to the earth and the comet [Luminarium ad terram Cometamq; proportio.], 335.
- The Moon was eclipsed by a comet [Luna à Cometâ fuit eclipſata.], 447.
- The Moon was observed close to the Sun around the new moon in the year 1553 [Luna circa Novilunium juxta Solem anno 1553 eſt obſervata.], 364.
- Who posit an atmosphere of the Moon [Lunæ atmoſphæram, quinam ſtatuant.], 366.
- Three moons appeared in the sky [Lunæ in cœlo apparuerunt tres.], 829.
- The border of the Moon fluctuated greatly in the solar eclipse of the year 1618 [Lunæ limbus in Ecclipſi Solari anno 1618 valdè fluctuabat.], 365.
- The proportion of the Moon and the Sun to the earth [Lunæ Solisq; ad terram proportio.], 335.
- The Moon: why does it not enjoy a motion of rotation like the other wandering stars? [Luna, cur non reliquorum inſtar Erronum motu gaudeat circumgyrationis ?], 430.
- Among the primary planets the Moon is not counted at all [Luna inter Planetas primarios habetur minimè.], 703.
- Although it is lower than the Moon, the comet is not on that account at once aerial [Lunâ,licet ſit Cometâ inferior, non ideò ſtatim eſt aêreus.], 447.
- The Moon does not always turn one and the same face toward us [Luna non ſemper unam eandemq; nobis obvertit faciem.], 708.
- The size of the lunar atmosphere [Lunaris atmoſphæræ magnitudo.], 365.
- A comet appeared at the time of a lunar eclipse [Lunaris Eclipſeos tempore Cometa apparuit[[./,]].], 809.

M.

- A most rare example of a solar spot observed by the Author [Maculæ alicujus Solaris ab Auctore obſervatæ, Exemplum rarisſimum.], 424.
- Spots and faculae of various kinds occur near the Sun [Maculæ & faculæ propè Solem dantur varii generis.], 360.

- Solar spots, faculae and shadows are subject to continual changes [Maculæ, faculæ atque umbræ Solares,continuis obnoxiæ ſunt mutationibus.], 508.
- Spots on the Earth are observed and seen from the Moon, just as on the Sun [Maculæ in Terrâ ex Lunâ, pariter ut in Sole obſervantur & videntur.], 368.
- Spots, if they are observed from the Sun or the Moon: in which part of the earth they are more frequent [Maculæ ſi ex Sole, vel Lunâ obſerventur, quâ in terræ parte dentur frequentiores.], 369.
- Spots, if they were to leave the vaporous orb of the Sun, would be subject to various motions in the same way as comets [Maculæ ſi orbem Solis vaporoſum exirent, eâdem ratione ut Cometæ diverſis ſubjicerentur motibus.], 699.
- Solar spots never leave the atmosphere [Maculæ Solares atmoſphæram nunquam exeunt.], 698.
    - solar spots are sometimes of very short duration [Solares breviſſimæ nonnũquam ſunt durationis.], 428.
    - solar spots do not rotate about an axis [Solares circa axem non rotantur.], 410.
    - solar spots contribute much light to comets, above all in respect of generation [Solares Cometis multùm conferunt luminis, imprimis ratione generationis.], 407.
    - solar spots agree extremely well with comets [Solares cum Cometis optimè conveniunt.], 349.
    - solar spots: why are they not generated around the Sun at every time? [Solares, cur non omni tempore circa Solem generentur ?], 652.
    - solar spots require an immense quantity of smoky evaporations [Solares immenſam fumidarum evaporationum copiam requirunt.], 403.
    - solar spots draw their light from the Sun [Solares Lumen ſuum ex Sole hauriunt.], 410.
    - solar spots: what kind of courses do they describe by their motion? [Solares motu ſuo quales deſcribunt ductus ?], 697.
- Certain solar spots: how often they return [Maculæ Solares nonnullæ, quoties redeant.], 409.
    - certain solar spots exceed the Moon and the Earth in diameter [Solares nonnullæ ratione diametri Lunam & Terram excedunt.], 401.
    - solar spots exercise almost no motion of their own, but only an apparent one [Solares nullum ferè motum proprium; ſed ſolummodò apparentem exercent], 698.
    - solar spots are never stationary or retrograde [Solares nunquam ſunt ſtationarii aut retrogradi.], 697.

    - solar spots agree best of all with comets [Solares omnium optimè cum Cometis conveniunt.], 566.
    - solar spots have their own zodiac, and some last longer than others [Solares peculiarem habent Zodiacum; atque aliæ aliis ſunt diuturniores.], 409.
    - how many solar spots, and of what kind, were noticed in the Sun's disc in one year [Solares quot & quales uno anno in Solis diſco ſunt animadverſæ.], 404.
- Terrestrial spots seen from the Sun are always whitish and very bright [Maculæ terreſtres ex Sole conſpectæ, ſemper ſunt albicantes & lucidiſſimæ.], 369.
    - terrestrial spots quite often travel across the Earth's disc [terreſtres Terræ diſcum ſæpius peragrantur.], 368.
- Spots, zones or bands on Jupiter [Maculæ Zonæ ſeu Faſciæ in Jove.], 371.
- A very notable solar spot detected by the Author in the year 1644 [Macula Solaris admodùm notabilis anno 1644 ab Auctore eſt deprehenſa.], 711.
- A solar spot detected with the meridian altitude in the year 1661 [Macula Solaris cum altitudine Meridianâ anno 1661 deprehenſa.], 721.
- When a solar spot lies outside the ecliptic in the northern part of the Sun, the shadow stands somewhat higher [Maculâ Solari extra Eclipticam in parte Solis Septentrionali verſante, umbra aliquantò elevatior exiſtit.], 479.
- The size of the solar spots and faculae, and of the shadows, with respect to the Sun [Macularum facularumq;, atque umbrarum Solarium magnitudo, reſpectu Solis.], 401.
- The remarkable change and alternation of the solar spots and faculae [Macularum facularumq; Solarium mira mutatio, atque vicisſitudo.], 360.
- The colour of the Jovian spots [Macularum Jovialium color.], 371.
- A description of the Jovian spots [Macularum Jovialium deſcriptio.], 371.
- The tails of the solar spots also point toward the side opposite the Sun [Macularum Solarium caudæ in oppoſitum quoque Solis vergunt.], 556.
- The shape of the bodies of the solar spots [Macularum Solarium corporum forma.], 419.
- There is a very great agreement between the solar spots and comets in respect of their properties and affections [Macularum ſolarium cum Cometis ratione proprietatum & affectionum magna admodùm eſt convenientia.], 407.
- The purpose of the delineation of the solar spots, and what is to be observed in these figures [Macularum ſolarium delineationis finis, & quid in iſtis iconiſmis obſervandum.], 411.
- The density and colour of the solar spots [Macularum ſolarium denſitas & color.], 408.

- The size of the apparent diameter of the solar spots at varying distance from the Earth, set out in a little table [Macularum ſolarium Diametri apparentis in diversâ à Terrâ diſtantiâ magnitudo, Tabellâ exhibita.], 402.
- The distance of the solar spots: is it always the same from the Sun? [Macularum ſolarium diſtantia, an ſit à Sole ſemper eadem ?], 410.
- The duration of the solar spots and of the nuclei [Macularum ſolarium, & Nucleorum duratio.], 409.
- The appearance and size of the solar spots, if they were viewed close at hand [Macularum ſolarium facies, & magnitudo, ſi cominùs ſpectarentur.], 402.
- The form, appearance and shape of the solar spots [Macularum ſolarium forma, ſpecies, figura.], 408.
    - the generation and corruption of the solar spots [ſolarium generatio, & corruptio.], 349,411.
    - the time of generation of the solar spots [ſolarium generationis tempus.], 408.
    - figures of the solar spots [ſolarium iconiſimi.], 411.
    - the increase and decrease of the solar spots [ſolarium incrementum, & decrementum.], 408.
    - the passing away of the solar spots [ſolarium interitus.], 410.
    - the size of the solar spots [ſolarium magnitudo.], 410.
    - the magnitude of the true diameter of the larger and smaller solar spots [ſolarium majorum & minorum veræ diametri quantitas.], 403.
- What the apparent motion of the solar spots is like [Macularum ſolarium motus apparens qualis.], 410.
    - the motion of the solar spots is most regular [ſolarium motus, eſt regulariſimus.], 410.
    - the proper motion of the solar spots is unequal [ſolarium motus proprius eſt inæqualis.], 410.
    - the motion of the solar spots: how it increases and decreases [ſolarium motus, quomodo creſcit, & decreſcit], 697.
    - the nature of the solar spots in growing and dissolving [ſolarium natura in creſcendo & diſſolvendo.], 424.
    - the nuclei of the solar spots grow and decrease [ſolarium nuclei creſcunt & decreſcunt.], 409.
    - the number of solar spots seen in the Sun in the year 1625 [ſolarium numerus in Sole anno 1625 conſpectarum.], 405.
    - the rise and origin of the solar spots [ſolarium ortus, & origo.], 360.
    - the physical and astronomical rise of the solar spots [ſolarium ortus Phyſicus, & Aſtronomicus.], 408.
    - phenomena from the Moon are detected only on the Earth [Phænomena ex Lunâ tantummodò in Terrâ deprehenduntur.], 369.

- The manner in which the solar spots are produced [Macularum ſolarium procreationis modus.], 408.
    - sudden appearances of the solar spots [ſolarium ſubitaneæ apparitiones.], 711.
    - sudden changes of the solar spots [ſolarium ſubitaneæ mutationes.], 424.
    - a concise description of the solar spots [ſolarium ſuccincta deſcriptio.], 407.
- The vicissitudes of the terrestrial spots seen from the Moon [Macularum terreſtrium, ex Lunâ conſpectarum vicisſitudines.], 369.
- That solar spots and faculae occur near the Sun [Maculas & faculas ſolares dari propè Solem.], 360.
- How many solar spots the Author detected in one year [Maculas ſolares, quot Auctor uno anno deprehenderit.], 404.
- The Sun sometimes has no spots [Maculas Sol interdum habet nullas.], 410.
- The size of the comet of 1652 as regards its head is to be marvelled at [Magnitudo Cometæ 1652 quoad caput admiranda.], 330, 336, 338.
- Mars: how many miles it covers through the motion of the first mobile in one second [Mars, quot milliaria motu primi mobilis unius ſcrupuli ſecundi conficiat.], 706.
- That Mars, Venus and Mercury also have their own attendants is not entirely out of keeping with reason [Martem, Venerem & Mercurium, ſuas etiam habere aſſeclas, rationi non planè abſonum.], 372.
- Matter for producing curved tails: which is suitable? [Materia ad producendas curvatas caudas, quænam ſit apta.], 498.
- Matter: one kind is more suited to motion than another [Materia, alia præ alia ad motionem eſt aptior.], 647.
- When the thinner matter around a comet fails, the tail also fails [Materiâ circa Cometam deficiente tenuiori, deficit quoque cauda.], 556.
- Rather dense matter lies hidden around comets [Materia circa Cometas latet denſiuſcula.], 476.
    - matter around the Moon is alterable and vaporous [circa Lunam datur alterabilis, & vaporoſa.], 363, 364,365.
    - celestial matter, like terrestrial, has a propensity to condensation from a certain innate natural faculty [cœleſtis,ut & terreſtris,ex inſitâ quâdam naturali facultate propenſionem habet ad condenſationem.], 383.
    - the matter of the heavens is sometimes finer and clearer, sometimes thicker and paler [cœli quandoque eſt ſubtilior & clarior, quandoque craſſior & pallidior.], 363.
- The matter surrounding the head of a comet has its own density [Materia Cometæ caput circumſtans, ſuam habet denſitatem.], 474.

- the more dilute matter of comets is not always so compressed that it can coalesce into more solid corpuscles [Cometarum dilutior non ſemper adeò conſtipatur, ut in corpuſcula coire posſit ſolidiora.], 477.
- the matter of comets is produced from the planets [Cometarum ex Planetis producitur.], 4[?]4.

- Cometary matter: is it coagulated and gathered into a ball about one centre? [Materia cometica, an ſuper uno centro coaguletur & conglobetur ?], 648.
  - not all cometary matter reaches as far as the outermost limits of the atmosphere [cometica non omnis, ad extremos usque atmoſphæræ terminos pertingit.], 647.
  - not all cometary matter is moved toward the same part of the heavens [cometica non omnis versùs eandem cœli partem commovetur.], 649.
- The principal cometary matter is found in the orb of the Sun [Materia cometica præcipua[[;/,]] in Solis datur Orbe.], 386.
  - cometary matter: by what means it acquires motion [cometica, quâ ratione motum acquirit.], 648.
  - cometary matter is not gathered together uniformly on every side with respect to its centre [cometica, ratione centri, non aggregatur uniformiter ab omni parte.], 564.
  - cometary matter, however unequal the motion it enjoys, nevertheless adheres, one part to another [cometica, ut ut inæquali gaudeat motu, alia tamen alii adhæret.], 647.
- Matter adhering to comets possesses different degrees of density and rarity [Materia Cometis adhærens, diverſos posſidet denſitatis, & raritatis gradus.], 498.
  - matter adhering to comets, as its density decreases, induces a convexity upward, but as it increases, a curvature of the tails downward [Cometis adhærens, denſitate decreſcens, convexitatem ſurſum, creſcens verò curvaturam caudarum deorſum inducit.], 499.
  - matter adhering to comets becomes successively finer and more dilute the more remote it is [Cometis adhærens remotior, ſubtilior, & dilutior ſucceſſivè fit.], 498.
- Matter adhering to comets: where it takes its origin [Materia Cometis adhærens[[;/,]]unde originem trahat.], 476.
- The nature of cometary matter [Materiæ cometicæ natura.], 647.
- The true place of cometary matter [Materiæ cometicæ verus locus.], 352.
- The quality and condition of the matter adhering to comets [Materiæ Cometis adhærentis qualitas & conditio.], 498,499.
- The operation of that liquid solar matter [Materiæ illius liquidæ Solaris operatio.], 359.

- The matter from which tails are produced: what kind is it? [Materia ex quâ caudæ procreantur, qualis ?], 481.
- That matter accompanying comets induces no refraction [Materia illa Cometas concomitans, nullam inducit refractionem.], 480.
- That matter lying hidden around a comet: how it grows into a great mass [Materia illa circa Cometam latens[[;/,]] quomodo in magnam molem excreſcat.], 478.
- That matter which accompanies comets is far thinner than our vaporous air [Materia illa, quæ Cometas concomitat, longè eſt tenuior aêre noſtro vaporoſo.], 480.
- Liquid matter in the Sun: what is it? [Materia liquida in Sole quid ?], 359.
- To distinguish the matter of comets, of which a comet is composed [Materiam Cometarum, ex quibus Cometa eſt compoſitus, dignoſcere.], 388.
- That the matter of comets contributes very greatly to their motion is proved, and not obscurely, by certain examples [Materiam Cometarum motui plurimùm conferre, exemplis quibusdam haud obſcurè probatur.], 693.
- The matter that adheres to comets: what kind is it? [Materia, quæ Cometis adhæret, qualis ?], 481.
- The further matter is removed from its body, the greater the impetus it acquires to move itself further [Materia quò magis à corpore ſuo elongatur [[;/,]] eò majorem acquirit impetum ſe ulteriùs movendi.], 648.
    - where the matter is the same, there the essence too is the same [ubi eſt eadem, ibi eadem quoque eſſentia.], 355.
    - the matter surrounding all the bodies of the world is liquid and of the same nature [univerſa mundana corpora ambiens [?] liquida eſt[[;/,]] ejusdemq; naturæ.], 355.
- The observation of the comet of 1580 by Matthiæ Meine [Matthiæ Meine, Cometæ 1580 Obſervatio.], 865.
- The maximum velocity, on the hypothesis by tangents, does not answer to the observations [Maxima velocitas, ex hypotheſi per tangentes, obſervationibus non reſpondet.], 784.
- The pith, as it were, of a tree, seen in the tail of the comet of 1618 [Medulla quaſi arboris in caudâ Cometæ 1618 viſa.], 881.
- No comet has been swifter than Mercury [Mercurio nullus Cometa velocior extitit.], 704.
- Mercury: how many miles it covers in the space of one second [Mercurius quot mill. unius ſcrupuli ſecundi ſpatio conficiat.], 703.
- The difference of meridians between Königsberg and Danzig [Meridianorum inter Regiomontum & Dantiſcum differentia.], 156.
- Meteors existing in the air always have a wandering motion [Meteora in aêre exiſtentia, vagum ſemper habent motum.], 133.

    - various meteors occur in the sublunary air [in aêre ſublunari contingunt varia.], 356.
    - meteors: of how many kinds? [quotuplicia ?], 356.
    - a great many solar meteors exist [Solaria quamplurima dantur.], 387.
- That so many meteors can be produced from the Earth is more to be marvelled at than that some comets are produced from so many celestial bodies [Meteora tot ex Terrâ procreari poſſe, magis eſt admirandum, quàm ex tot corporibus cœleſtibus nonnullos Cometas.], 399.
    - as meteors are produced in the air, so new stars and comets are produced in the aether [ut in aêre,ſic nova aſtra & Cometæ in æthere procreantur.], 354.
- The place where fiery meteors are generated [Meteorum ignitorum generandi locus.], 356.
- A method of recognising whether any parallax lies hidden in refraction [Methodus cognoſcendi, an aliqua in refractione lateat parallaxis ?], 274.
    - a method of deriving the prosthaphaeresis of the inclination [eruendi Proſthaphæreſin inclinationis.], 191.
- A method, hitherto unknown, of finding the difference of parallax [Methodus hactenus incognita, parallaxeos differentiam inveniendi.], 257.
- A method of investigating the digressions of a comet from the Sun [Methodus inveſtigandi Cometæ à Sole digreſſiones.], 79.
    - a method of investigating longitude and latitude from declinations and right ascensions [inveſtigandi, ex declinationibus & aſcenſionibus rectis, Longitudinem, & Latitudinem.], 68.
    - a method of finding the declination and right ascension of comets from altitudes and azimuths [inveniendi, ex altitudinibus & azymuthis Cometarum declinationem, & aſcenſionemrectam.], 25.
    - a method of finding the longitude and latitude of the comet of the year 1652 from its distances from certain fixed stars [inveniendi, ex diſtant. certarum Fixarum Cometæ anni 1652 Longitudinem & Latitudinem.], 37, 39, 41, 43, 45, 47, 48, 50, 52, 54, 55.
    - a method of finding the final equation of parallax [inveniendi parallaxeos æquationem ultimam.], 193.
    - a method of finding the equated parallax of the orbit, reduced to the vertical [inveniendi parallaxin orbitæ coæquatam, & ad verticalem reductam.], 189.
    - a method of inquiring into the first prosthaphaeresis itself of the inclination [inquirendi Proſthaphæreſin ipſam inclinationis primam.], 196.
    - a new method of deriving the difference of parallaxes [nova parallaxium differentiam eruendi.], 199.
- A method of deriving parallaxes from declinations and latitudes [Methodus parallaxes ex declinationibus & latitudinibus eruendi.], 292.

    - a method of computing the diameter of a comet [ſupputandi Cometæ Diametrum.], 333.
    - a method of computing a comet's declinations and right ascensions from its longitude and latitude [ſupputandi ex Cometæ Longitudine & Latitudine ejus declinationes & aſcenſiones rectas.], 75.
    - a method of computing the angle of inclination [ſupputandi inclinationis angulum.], 197.
    - a method of computing the true parallax, equated a second time, vertical [ſupputandi parallaxin veram, ſecundò coæquatam verticalem.], 198.
- A method of computing the first prosthaphaeresis of the inclination [Methodus ſupputandi proſthaphæreſin inclinationis primam[[;/:]]], 196.
- Michael Mästlin's observation of the comet of 1580 [Michaëlis Mæſtlini Cometæ 1580 obſervatio.], 862.
- The flickering and twinkling of the tail: when it is swiftest and most frequent [Micatio, & ſcintillatio caudæ, quando eſt velociſſima, & frequentiſſima.], 512.
- The remarkable difference in the aspect of a comet 20 miles distant from the Earth [Mira diverſitas adſpectûs Cometæ à Terrâ 20 mill. remoti.], 140.
- The manner of determining the time at which the comet of 1652 crossed the equator and the ecliptic [Modus indagandi tempus, quo Cometa 1652 Æquatorem, Ecclipticamq́; trajecerit.], 124.
    - the manner of investigating the proper and the daily motion, the angle of the orbit, and the place of the node [inveſtigandi motum proprium & diurnum, angulum orbitæ, & locum nodi.], 87.
    - the manner of proceeding when no difference of distances is given [procedendi, ubi nulla datur diſtantiarum differentia.], 216.
    - Regiomontanus's manner of inquiring into parallaxes is unreliable [Regiomontanus parallaxes inquirendi lubricus.], 165.
- Given a motion that is straight at first, comets travel across in no other way than with a nearly straight motion [Motu dato primùm recto, Cometæ haud aliter, quàm motu propemodùm recto trajiciunt.], 587.
- According to the Author, comets are carried with a nearly straight motion [Motu propemodùm recto Cometæ ſecundùm Auctorem feruntur.], 568.
- What is driven by a straight motion is always swifter than what is carried by an oblique one [Motu quod agitur recto, velocius ſemper eſt, quàm quod fertur obliquo.], 184.
    - given a motion of the Earth, there is no straight motion on the Earth [terræ dato, nullus datur in terrâ motus rectus.], 664.
    - given a motion of the Earth, in what place a straight motion may exist [terræ dato, quo in loco detur motus rectus.], 664.

- That the proper motion of the comet has been correctly reported is demonstrated [Motum Cometæ proprium, rectè esſe traditum demonſtratur.], 180.
    - that the true proper motion of the comet of 1872 was at first much slower than afterwards is demonstrated by a diagram [Cometæ 1872 verum proprium, initio multò fuisſe tardiorem, quàm deinceps, Schemate demonſtratur.], 687.
    - that the daily motion of the comet of 1664, on 4 February, was not greater than 5′ is confirmed by the hypothesis from tangents [diurnum Cometæ 1664 die 4 Febr. haud fuisſe majorem 5 minut. hypotheſi ex tangentibus comprobatur.], 789.
    - between the motions of the planets and of the comets there is a remarkable affinity and harmony [inter Planetarum, & Cometarum admiranda intercedit affinitas, atque harmonia.], 704.
- Very few comets have a contrary motion of the nodes [Motum Nodorum adverſum, paucisſimi habent Cometæ.], 743.
- To know the motion of the nuclei [Motum Nucleorum cognoſcere.], 344.
- Many philosophers hold that a wholly straight motion hardly exists in all of nature [Motum omninò rectum in totâ naturâ vix dari, multi Philoſophi ſtatuunt.], 659.
- In parallaxes it matters greatly to know the proper motion correctly [Motum proprium rectè cognoſcere in parallaxibus multùm intereſt.], 174.
- The Copernicans grant no straight motion in nature [Motum rectum Copernicæi in naturâ concedunt nullum.], 663.
    - what impedes the straight motion of a projected stone [rectum Lapidis projecti quid impediat.], 654.
    - the more something is driven round in a circle, the more vehement the motion it acquires for itself [ſibi acquirit eò vehementiorem, quò quid magis in gyrum ducitur.], 645.
    - all comets possess a supremely regular motion, even though their gait seems most disordered [ſummè regularem Cometæ posſident omnes, licet videantur inceſsûs inordinatisſimi.], 634.
    - what slows or speeds up the motion of comets as well as of planets [tam Cometarum, quàm Planetarum quid retardet vel acceleret.], 705.
    - a motion of the earth must be assumed in regard to the trajections of comets [terræ circa trajectiones Cometarum ſupponere oportet.], 589.
- The motion of some cometary body: how it is changed by the encounter of another [Motus alicujus corporis cometici, occurſu alterius, quomodo mutatur ?], 650.

- the motion of some body: how it is produced, propagated and conserved [alicujus corporis quomodo procreetur, propagetur, & conſervetur.], 646.
- the apparent motion of the angle of inclination of comets: what is it like with respect to the elongation from the Sun and the Earth? [anguli inclinationis apparens Cometarum, rationeelongationis à Sole & Terrâ qualis ?], 136.
- the apparent daily motion is not always greatest where the comet is nearest the Earth [apparens diurnus, non ſemper ubi Cometa Terræ proximus, maximus eſt.], 640.

- Motion and impetus: in how many ways they can be produced [Motus atq;impetus,quotupliciter procreari poteſt.], 645.
  - a definite libratory or oscillatory motion occurs in comets too, just as in the Moon [certus libratorius, vel oſcillatorius, prout in Lunâ, ſic in Cometis etiam datur.], 708.
  - circular motion, and rotation, lasts as long as the endeavour remains vigorous and is renewed, as it were, at every single moment [circularis,& circumgyratio tamdiu durat, quamdiu conatus viget, & quaſi ſingulis momentis renovatur.], 646.
  - circular motion: what is it like? [circularis qualis ?], 560.
  - circular or elliptical motion: to which bodies it is suited [circularis ſeu Ellipticus, quibus corporibus conveniat.], 569.
- A motion of rotation does not belong to comets [Motus circumgyrationis non competit Cometis.], 430,431.
- The proper daily motion of the comet of 1652 was not always equal [Motus Cometæ 1652 diurnus proprius, æqualis ſemper non fuit.], 131.
  - the proper motion of the comet of 1652, though it appeared unequal, nevertheless remained regular right to the end [Cometæ 1652 proprius, licet inæqualis apparuerit, regularis tamen usq́ue ad finem extitit.], 131.
  - the apparent motion of the comet of 1664 was swiftest in the middle and slacker at either extremity [Cometæ 1664 apparens, in medio velociſſimus, in utraq́ue extremitate remiſſior extitit.], 761.
  - the true motion of the comet of 1661 [Cometæ 1661 verus.], 750.
  - the discrepancy between the motion of the comet of 1664 and the motion of the comet of 1661 [Cometæ 1664, inter Cometæ 1661 motum discrepantia.], 765.
  - the proper motion of the comet of 1661; the angle of the orbit and of the equator, with the place of the intersection [Cometæ 1661 proprius,Angulus orbitæ & æquatoris, cum loco interſectionis.], 740.
  - the true motion of the comet of 1661: was it equal? [Cometæ 1661 verus, an fuerit æqualis ?], 750.

- the motion of the comet of 1664: why was it swiftest at the start, and then gradually slacker? [Cometæ 1664, cur initiò extiterit velocisſimus, & deindè paullatim remisſior ?], 766.
- the motion of the comet of 1664 in its path: what was it like? [Cometæ 1664 in Traject. qualis extitit ?], 765&766.
- the true motion of the comet of 1664 became slower day by day [Cometæ 1664 verus,ſegnior indies eſt redditus.], 761.

- The apparent motion of the comet of 1665 corresponds, according to the theory, to the observations themselves [Motus Cometæ 1665 apparens, ſecundùm Theoriam, ipſis obſervationibus reſpondet.], 768.
  - the motion of the comet of 1665 grows stronger day by day [Cometæ 1665 in dies invaleſcit.], 768.
  - the true motion of the comet of 1665: what was it like in its path? [Cometæ 1665 verus, in Trajectoriâ qualis extitit ?], 768.
  - the true motion of the comet of 1665: how, and by how much, it increased [Cometæ 1665 verus, quomodo, & in quantum crevit.], 771.
  - the true motion of the comet of 1665: how and by how much it decreased [Cometæ 1665 verus, quomodo & in quantum decrevit.], 772.
  - the proper motion of a comet is, in certain cases, itself the parallax sought [Cometæ proprius, certis in caſibus ipſa eſt parallaxis quæſita.], 216.
  - the apparent proper motion of a comet: when it is greater than the true one [Cometæ proprius viſus, quando vero eſt major.], 175.
- The motion of comets: to which section does it come nearer? [Motus Cometarum, ad quam ſectionem magis accedat.], 683.
- The motion of comets: does it take its beginning on the axis, or rather at the bottom of the parabola? [Motus Cometarum, an in axe, an verò in fundo parabolæ initium ducat ?], 667.
- God is the first cause of the motion of comets [Motûs Cometarum cauſa prima, DEUS eſt.], 644.
  - the second cause of the motion of comets: what is it? [Cometarum cauſa ſecunda, quænam ſit ?], 644.
- The motion of comets is best compared with the motion of ships [Motus Cometarum cum motu navium optimè confertur.], 571.
  - the motion of comets: why is it not always uniform? [Cometarum, cur non perpetuò ſit æquabilis ?], 654.
- The variation of the daily motion of comets [Motûs Cometarum diurni diverſitas.], 322.
  - a comparison of the motion of comets and of the first mobile [Cometarum, & primi mobilis comparatio.], 706.

- The motion of comets from the Sun does not vary with the distance of the comets [Motus Cometarum ex Sole, ad diſtantiam Cometarum non variatur.], 753.
    - the motion of comets differs in certain respects from the motion of projected or exploded bodies [Cometarum,in quibusdam à projectorum, vel exploſorum motu differt.], 677.
    - the motion of comets in the path is never equal [Cometarum inTrajectoriâ,nunquam eſt æqualis.], 751.
    - the motion of comets in the path is indeed unequal, but by no means disordered [Cometarum in Trajectoriâ quidem eſt inæqualis, ſed minimè inordinatus.], 676.
    - the motion of comets according to the Author: what it is like [Cometarum juxta Auctorem qualis.], 568.
    - the libratory motion of comets is now greater, now less, according to the varying position of the comet relative to the Sun and the Earth [Cometarum libratorius,pro vario Cometæ ad Solem Terramq́; ſitu, nunc major, nunc minor eſt.], 709.
    - the motion of comets emulates the motion of the planets [Cometarum, motum Planetarum æmulatur.], 708.
    - neither the true nor the apparent motion of comets is correctly determined by tangents [Cometarum nec verus,nec apparens, per Tangentes rectè definitur.], 777.
    - the slowest and the swiftest motion of certain comets, set out in a little table [Cometarum nonnullorum tardiſſimus, velociſſimusq́; in tabellam redactus.], 702 & 707.
- The motion of comets is not always one and the same [Motus Cometarum non ſemper unus idemq́; eſt.], 752.
    - the motion of comets never becomes entirely straight [Cometarum nunquam fit omninò rectus.], 680.
    - an entirely curved motion of comets can be saved by an almost straight path [Cometarum omninò curvus, per rectam penè ſalvari poteſt Trajectoriam.], 746.
    - the parabolic motion of comets is made clear by a diagram and by a sailing course [Cometarum parabolicus, Schemate atq́ue curſu velifico dilucidatur.], 681.
    - the proper motion of comets is much slower on the Ptolemaic theory [Cometarum proprius, ex Ptolemaicâ Theoriâ multò eſt tardior.], 707.
    - the proper motion of comets: what it is like [Cometarum proprius,qualis.], 559.
    - the motion of comets along straight lines was demonstrated by Kepler, first of all [Cometarum per lineas rectas, primum omnium à Keplero demonſtratus eſt.], 591.

- the motion of comets is best of all demonstrated by the motion of sailing [Cometarum, per motum velificationis omnium optimè demonſtratur.], 577.
- the motion of comets: how it is carried out by God [Cometarum, quomodo à DEO peragitur.], 644.
- the motion of comets: what it is like, and in what way it is implanted in them [Cometarum qualis eſt, & quâ ratione illis inditur.], 648.

- The motion of comets: for what cause it becomes non-uniform, and in part curved [Motus Cometarum, quam ob cauſam redditur inæquabilis, & ex parte incurvatus.], 655.
  - the motion of comets: when is it intensified and slackened? [Cometarum, quando intenditur, & remittitur ?], 687.
  - the motion of comets: by what means it can most easily be worked out [Cometarum, quâ ratione facillimè expediri poſſit.], 643.
  - the motion of comets: why is it, in certain comets, now slower, now faster? [Cometarum, unde in quibusdam Cometis nunc ſegnior, nunc velocior ſit ?], 693,694.
  - the motion of comets: why and from what does it grow, and decrease again? [Cometarum, quare & unde creſcit, rurſusq; decreſcit ?], 674.
  - the motion of comets: how is it accelerated? [Cometarum,quomodo acceleratur ?], 695.
  - the motion of comets: how and when it is increased [Cometarum,quomodo & quando augetur.], 672.
  - the motion of comets: how it is carried out on a parabolic line; and also how the inclination of the disc varies unceasingly; shown by a diagram [Cometarum, quomodo in lineâ peragitur parabolicâ; tum quomodo inclinatio diſci indeſinenter variatur; Schemate declaratur.], 670.
- The motion of comets: how it behaves with respect to the planets [Motus Cometarum, quomodo ſe habet reſpectu Planetarum.], 700.
  - the rectilinear motion of comets: how it is to be understood [Cometarum rectilineus, quomodo accipiendus.], 567.
  - the motion of comets, proper as well as apparent, in the path differs utterly from the motion of the solar spots [Cometarum tàm proprius in Trajectoriâ, quàm apparens, cum macularum Solarium motu, toto cœlo discrepat.], 698.
  - the motion of comets: where it is swiftest [Cometarum ubi eſt celerrimus.], 669.
  - the motion of comets is swifter than the sailing course of ships, indeed than the flight of birds and the motion of sound [Cometarum, velifico navium curſu, imo volatu avium,& motu Soni eſt velocior.], 702.

- The true proper motion of comets in the path is to be considered both from the Earth and from the Sun [Motus Cometarum verus proprius in Trajectoriâ, tam ex Terrâ, quàm ex Sole conſiderandus eſt.], 700.
    - the swiftest motion of comets: how great it is on the Ptolemaic theory [Cometarum velocisſimus,ex Ptolemaicâ Theoriâ quantus eſt.], 707.
    - the swiftest motion of comets: how great it is [Cometarum velocisſimus quantus.], 702.
    - the motion of comets: from what source, and when, it varies [Cometarum,unde & quando variatur.], 675.
    - the common motion is, for the Peripatetics, immensely swifter than even the swiftest motion of comets [communis immane quantum Peripateticis eſt velocior, motu Cometarum etiam velocisſimo.], 707.
    - continuous and eternal motion: to which bodies it is attributed [continuus & æternus, quibus tribuitur corporibus.], 569.
    - the motion of disc-shaped bodies is best made clear by sailing [corporum diſceorum, per velificationem optimè dilucidatur.], 656.
    - the motion of a disciform body: how it is slowed, twisted aside, and accelerated again [corporis diſciformis, quomodo retardetur, obtorqueatur, & rursùs acceleretur.], 571.
- Motion: why is it found so varied in comets? [Motus, cur in Cometis adeò detur diverſus ?], 690.
- The motion and course of the haired stars [Motus curſuſq; crinitorum Siderum.], 646.
    - the motion of disc-shaped bodies: from what source it is accelerated and slowed [diſceorum corporum, unde acceleretur & retardetur.], 673.
    - the daily motion of the comet of 1652 upon its own trace: how great it was [diurnus Cometæ 1652 ſuper ſuo veſtigio quantus.], 597.
    - the daily motion of the comet of 1664 is restored, on the hypothesis from tangents, by the motion of the nodes [diurnus Cometæ 1664, juxta hypotheſin ex tangentibus motu nodorum reſtituitur.], 789.
    - the slowest and the swiftest daily motion of comets: how many semidiameters of the Earth it amounted to [diurnus Cometarum tardisſimus & celerrimus, quot Semid. T. extiterit.], 701.
    - motion is the more difficult and the slower, the greater the resistance [eò eſt difficilior tardiorq́;, quò major eſt reſiſtentia.], 584.
- Motion, and a remarkable impetus, are excited by rotation and whirling [Motus, & impetus inſignis ex circumgyratione, & vertigine excitatur.], 645.
- Motion from rotation and whirling: in what way it is excited [Motus ex circumgyratione,& vertigine,quâ ratione excitetur.], 645.

- the motion of exploded bodies: where is it swiftest? [explosorum, ubi est velocissimus ?], 669.
- the motion of unequal falling globes: why is it equally swift? [globorum inæqualium cadentium, cur sit æque velox ?], 573.
- the motion of globes is not a section of a circle [globorum, non est sectio circuli.], 660.

- The nature of the motion of gravity [Motus gravitatis natura.], 662.
  - the motion of gravity gradually grows stronger [gravitatis sensim invalescit.], 662.
  - that swiftest motion of comets, assigned to comets by the Author: does it not run counter to nature? [ille Cometarum velocissimus, Cometis ab Auctore assignatus, an naturæ non adversetur ?], 702.
  - impressed motion is gradually weakened [impressus paullatim debilitatur.], 662.
  - impressed motion, or the impelling force, is always stronger at the beginning [impressus, seu vis impellens,initiò semper est fortior.], 661, 662.
  - in the aerial region, motion is always wandering [in aëreâ regione perpetuò datur vagus.], 132.
  - motion on an axis: to which bodies it belongs [in axe, quibus competat corporibus.], 430.
  - the motion of the inclination of the orbit and of the nodes of the comets of 1531, 1532 and 1533 [inclinationis orbitæ, & Nodorum Cometarum 1531, 1532 & 1533.], 120.
- The motion of a projected stone: for what cause it is partly curved and progressively slowed [Motus lapidis projecti, quâ de caussâ parte incurvetur, & succesivè retardetur.], 654.
  - libratory motion: from what it arises [libratorius unde oriatur.], 708.
  - the motion of the spots: why is it so regular and constant? [macularum, cur tam regularis est,atque constans ?], 697, 698.
  - a comparison of the motion of the solar spots and of comets [Macularum Solarium, & Cometarum comparatio.], 696.
  - the motion of the spots: from what it proceeds [Macularum unde proficiscatur.], 698.
  - the natural motion of descending heavy bodies and of trajected bodies: how they differ from violent motion [naturalis gravium descendentium & Trajectorum,quomodo differunt à motu violento.], 573.
  - natural motion finally destroys impressed motion [naturalis, motum impressum ultimò destruit.], 662.
  - all motion becomes straight of itself; and from what cause? [omnis ex se ipso fit rectus, & unde ?], 645.
  - the motion of the orbit and of the ecliptic of the comet of 1585 [Orbitæ & Eccliptícæ Cometæ 1585.], 119.

- Parabolic, elliptical and circular motion is described, namely, from two straight motions [Motus parabolicus, Ellipticus & circularis, ex duobus motibus rectis ſcilicet deſcribitur.], 662.
- Parabolic motion also has a place in the air [Motus parabolicus in aëre etiam locum habet.], 659.
- Parabolic motion in a horizontal direction: how it comes about [Motus parabolicus in directione horizontali quomodo fiat.], 661.
    - all parabolic motion is straighter at the beginning and at the end, but more curved in the middle [parabolicus omnis, initiò & in fine eſt rectior, in medio verò curvior.], 663.
    - parabolic motion: by what things it is demonstrated [parabolicus quibus rebus demonſtretur.], 660.
    - the motion of the phenomenon: when it is contrary to the motion of the Earth [Phænomeni, quando contrarius exiſtit motui Terræ.], 639.
    - the motion of the phenomenon: when it follows the motion of the Earth [Phænomeni, quando Terræ motum ſequitur.], 639.
    - the first motion of the cometary matter: how it is induced [primus materiæ cometicæ,quomodo inducatur.], 647.
    - the motion of projected bodies is compounded of a straight and an inclined motion [projectorum, ex motu recto, & inclinato componitur.], 662.
- The proportion of motion between the planets and the comets is the same on the looser as on the stricter hypothesis [Motûs proportio inter Planetas, & Cometas tam ex laxiori, quam ſtrictiori hypotheſi eſt eadem.], 708.
- The proportion of motion, of comets as well as of planets, is always the same on every hypothesis [Motûs proportio, tam Cometarum, quàm Planetarum, ex omni hypotheſi ſemper eſt eadem.], 703.
- The proper motion of comets is faster in some comets and, by contrast, slower in others [Motus proprius Cometarum in aliis Cometis velocior, in aliis rursùs tardior eſt.], 622.
    - the proper motion in some comets now increases, now decreases [proprius in nonnullis Cometis modò creſcit, modò decreſcit.], 632.
    - the true proper motion of the comet of 1590 [proprius verus Cometæ 1590.], 622.
    - the true proper motion of the comet of 1507 [proprius verus Cometæ 1507.], 623.
    - the true proper motion of the comet of 1652 [proprius verus Cometæ 1652.], 632.
    - the motion of fresh cometary matter in the atmosphere is spiral, like a helical line [recentis materiæ cometicæ in atmoſphærâ ſpiralis eſt, inſtar lineæ helicæ.], 670.

    - the reciprocating motion of comets is explained and demonstrated by a diagram [reciprocatorius Cometarum, Schemate declaratur, & demonſtratur.], 709.
    - the reciprocating motion can scarcely be grasped by fixed rules [reciprocatorius comprehendi certis regulis vix poteſt.], 710.
- To explain the origin of the rectilinear trajectory motion is a hard task [Motus rectilinei Trajectorii originem explicare,arduum eſt negotium.], 643.
    - rectilinear motion: why does it suit all comets better than circular motion? [rectilineus, cur omnibus Cometis magis, quàm circularis conveniat ?], 568.
    - straight motion: is there any in nature? [rectus, an in natura aliquis detur ?], 664.
    - straight motion: to which bodies it belongs [rectus, quibus corporibus competat.], 569.
    - a motion once impressed is equal by its own nature and of itself [ſemel impreſſus,ſuapte naturâ & per ſe eſt æqualis.], 654.
    - the motion of the Sun is found to be far more vigorous about the equator than about the poles [Solis, circa æquatorem longè datur vehementior, quàm circa Polos.], 753.
    - motion persists by its own nature until it is slowed [ſuapte naturâ perſeveratur, donec retardetur.], 648.
    - the annual motion of the Earth produces variation in comets [Terræ annuus, Cometis diverſitatem parit.], 700.
    - the daily motion of the Earth: why is it not equal in every place on earth? [Terræ diurnus, cur non omni terrarum loco ſit æqualis ?], 665.
    - the motion of the Earth: where does it almost vanish, and where, on the other hand, is it swiftest? [Terræ ubi penè evaneſcit, & vicisſim ubi eſt velocisſimus ?], 665.
- Trajectory motion: does it suit the comet of Regiomontanus? [Motus trajectorius, an Cometæ Regiomontani conveniat ?], 603.
    - trajectory motion by no means corresponds to the interval of the comet from the Sun [trajectorius, intervallo Cometæ à Sole minimè reſpondet.], 752.
    - trajectory motion: how it is preserved even with the Earth at rest [trajectorius, quâ ratione terrâ etiam ſtabili conſervatur.], 589.
    - the motion: where it is slower, and again where it is faster [ubi ſegnior eſt, & rursùs ubi celerior.], 675.
- The difference between the true and the apparent motion: in what case it is greatest of all [Motûs veri & viſi differentia, quo in caſu ſit omnium maxima.], 184.

    - the true motion of the comet of 1664: why is it obtained more easily than that of the comet of 1661? [Motus verus Cometæ 1664, quare faciliùs quàm Cometæ 1661 obtinetur ?], 756.
    - the true motion in an oblique path: how it is investigated [verus in Trajectoriâ obliquâ, quomodo inquiritur.], 598.
    - violent impressed motion surpasses natural motion at the beginning [violentus impreſsus,motum naturalem principiò antecellit.], 662.
    - violent impressed motion: what it is [violentus impreſsus quid ſit.], 661.
    - the apparent motion: how it is to be bounded, by a different method now devised for the first time by the Author [viſus, diversâ nunc primum ab Auctore inventâ ratione, quomodo limitandus.], 184.
- The apparent motion: when is it greater than the true one? [Motus viſus quando vero eſt major ?], 174.
- The apparent motion: when is it less than the true one [Motus viſus quando vero eſt minor.], 176.
- Theorems on motions and trajections [Motuum & Trajectionum Theoremata.], 638.
- The power of moving: what it is [Movendi potentia quænam.], 578.
- All the bodies of the world have their own atmospheres, in which various changes, alterations and generations take place [Mundana corpora omnia ſuas habent Atmoſphæras, in quibus variæ mutationes, alterationes atque generationes accidunt.], 382.
- All the bodies of the world were made according to the same rule of divine art [Mundana corpora univerſa, ad eandem divinæ artis amuſim condita ſunt.], 355.
- All the bodies of the world emit exhalations [Mundana corpora univerſa,emittunt exſpirationes.], 380.
- Whether the world is infinite, granted a straight motion of comets [Mundus an ſit infinitus, dato Cometarum motu recto.], 567.
- The size and vastness of the whole world [Mundi totius magnitudo & vaſtitas.], 407.

N.

- The first birth of comets [Nativitas Cometarum prima.], 384.
- Nature produces nothing without matter [Natura citra materiam nihil procreat.], 352.
- Nature abhors what is idle and superfluous [Natura otioſa & ſuperflua abominatur.], 372.
- The investigator of nature always prefers reasons and observations to authority [Naturæ Scrutator ſemper rationes & obſervationes præfert Auctoritati.], 423.
- The movement of ships: the more water strikes the rudder, the more vehement and the more oblique it is [Navium commotio, quò plùs aquæ temonem ferit, eò eſt vehementior, & obliquior.], 580.

- Ships: why they need longer rudders in shallow waters [Navigia, cur in aquis vadoſis temonibus opus habeant longioribus.], 582.
    - ships: why are they built oblong? [cur ſtruantur oblonga ?], 576.
    - ships set moving in a river by a fixed law likewise describe a parabolic course, as comets do in the aether [in flumine certâ lege commota, pariter curſum deſcribunt parabolicum, ut Cometæ in æthere.], 681.
    - ships: when they are carried more slowly, and in turn when more swiftly [quando tardiùs, & vicisſim quando velociùs feruntur.], 675.
    - ships describe sometimes a whole parabola, sometimes a semi-parabola [quandoq́ue integram, quandoq́ue ſemiparabolam deſcribunt.], 682.
    - ships: in what place they exert a swifter motion [quo in loco concitatiorem exercent motum.], 681.
- The principle of steering is the same for ships as for comets [Navigiorum directionis ratio eadem eſt, ac Cometarum.], 681.
- The rudder of ships is rightly counted among the wonders of nature [Navigiorum gubernaculum, inter admiranda Naturæ meritò refertur.], 576.
- A ship: by what means it proceeds at a certain angle of inclination [Navigium, quâ ratione ſub certo inclinationis angulo procedit.], 580.
- A ship by its nature leans toward the side where the passage is easier and the resistance less [Navis natura illorſùm propendet, quorſùm facilior datur tranſitus, minorq́; renixus.], 681.
- The shorter a ship is, the more easily it can be steered [Navis quò eſt brevior, eò faciliùs dirigi poteſt.], 584.
- The Author considers that the structure of ships was taken from fishes, and their steering by means of the rudder from the fishes' tails and fins [Navium ſtructuram à piſcibus, directionem verò ope gubernaculi ab ipſorum caudis, & pinnis petitam eſſe, Auctori videtur.], 587.
- Mists are sometimes detected on the Moon [Nebulæ quandoq́ue in Lunâ deprehenduntur.], 367.
- The requisites needed for obscuring the planets [Neceſſaria requiſita ad obſcurandos Planetas.], 548,549.
- Things neglected by the Ancients are to be pursued all the more eagerly [Neglecta ab Antiquis, eò alacriùs ſunt peragenda.], 437.
- The business of comets is the most difficult of all [Negotium Cometarum omnium eſt difficillimum.], 139.
- Comets seen in the time of Nero [Neronis tempore,Cometæ viſi.], 803.
- Nicephorus's observation of a comet [Nicephori obſervatio Cometæ.], 350, 351.
- In the time of Nicephorus a wondrous comet appeared [Nicephori tempore, mirus Cometa apparuit.], 807.
- A demonstration of the nodes and of the angle of inclination [Nodi atq́ue Anguli inclinationis demonſtratio.], 115.

    - the motion of the northern node of the comet of 1652 [Borei motus Cometæ 1652.], 111.
    - the nodes of the planets vary [Planetarum variantur.], 135.
    - the nodes: by how great a distance they advance each year [quanto ſpatio ſingulis annis progrediantur.], 135.
- The motion of the nodes and of the inclination of the orbit of the comets of 1531, 1532, 1533 and 1585 [Nodorum & inclinationis orbitæ motus Cometarum 1531,1532, 1533 & 1585.], 120.
    - that the hypothesis from tangents can to some extent be rescued by the motion of the nodes is demonstrated by the comet of 1661, 1664 and 1665 [motu, hypotheſi ex tangentibus ſubveniri quadantenus poſſe, Cometâ demonſtratur 1661, 1664 & 1665.], 788 & 789.
    - very few comets have a contrary motion of the nodes [motum adverſum, paucisſimi habent Cometæ.], 743.
- The motion of the nodes is the greatest obstacle to the theory that is built from tangents [Nodorum motus, Theoriæ, quæ ex Tangentibus conſtruitur, maximè obſtat.], 777,787.
- Which among the authors held the node and the angle of the orbit to be fixed [Nodum, Angulumq́; orbitæ fixum, inter Auctores quinam ſtatuerint.], 113.
- The node of the comet of 1577 according to Tycho's calculation [Nodus Cometæ 1577 ſecundùm calculũ Tychonis.], 113.
    - the node of the comet of 1577 according to the Author's calculation [Cometæ 1577 juxta calculum Auctoris.], 115.
    - the node of the comet of 1590 according to the Author's calculation [Cometæ 1590 ſecundùm calculum Auctoris.], 117.
    - the node of the comet of 1618 from Crüger's observations and the Author's calculation [Cometæ 1618 ex obſervat. Crügeri & calculo Auctoris.], 119.
    - the node of the comet of 1652 was subject to variation [Cometæ 1652 variationi fuit obnoxius.], 111.
- Not all things that hold good in theory and can be demonstrated are properly carried over into practice [Non univerſa, quæ in ſpeculatione rectè ſe habent, ac demonſtrari poſſunt, ad praxin ritè deducuntur.], 165.
- New stars surpass comets in brightness [Novæ Stellæ, claritate Cometas ſuperant.], 391.
    - the magnitude of the new star in Cassiopeia in the year 1572 [Stellæ in Caſſiopeâ anno 1572 magnitudo.], 394.
    - new stars have no hair [Stellæ nullam habent comam.], 391.
    - new stars: why do they arise more often in the Milky Way? [Stellæ, quare in viâ lacteâ ſæpius exoriantur ?], 424.
    - new stars always twinkle [Stellæ ſemper ſcintillant.], 433.
- The remarkable new star in the neck of Cetus [Nova Stella in collo Ceti admiranda.], 376.

- A description of the new stars [Novarum Stellarum deſcriptio.], 384.
  - the time of birth of new stars and of comets [Stellarum & Cometarum naſcendi tempus.], 426.
  - the manner of birth and of passing away is not the same for new stars and for comets [Stellarum & Cometarum non eadem eſt naſcendi & occidendi ratio.], 390, 391,422.
  - the manner in which new stars arise [Stellarum exoriendi ratio.], 423.
  - the birth of new stars is much more difficult than that of comets [Stellarum Nativitas multò eſt difficilior, quàm Cometarum.], 422.
- It is very probable that new stars can arise rather often out of the exhalations of so many fixed stars, and set again, even though they are not detected by us [Novas Stellas ex tot ac tot Fixarum exhalationibus oriri ſæpiusculè, ac rurſus occidere poſſe, ut ut à nobis non deprehendantur, valdè eſt probabile.], 399.
- The generation and corruption of new stars [Novorum Siderum Generatio & corruptio.], 391,421.
- The nuclei of comets: some are brighter than others [Nuclei Cometarum, alii aliis ſunt ſplendidiores.], 435.
  - the nuclei of comets increase and decrease [Cometarum creſcunt ac decreſcunt.], 435.
  - the nuclei of comets are surrounded by a certain rarer matter [Cometarum, materiâ quâdam cinguntur rariori.], 435.
  - the nuclei of comets exhibit a peculiar anomalous motion [Cometarum, peculiarem exercent motum anomalum.], 436.
  - the nuclei of which the cometary head consists are not of perfect roundness [ex quibus Caput cometicum conſtat, perfectæ non ſunt rotunditatis.], 350.
  - nuclei arise more slowly in the Sun [in Sole naſcuntur tardiùs.], 409.
  - the nuclei of the solar spots do not always occupy the centre of the spots [Macularum Solarium, centrum in maculis non ſemper obtinent.], 409.
  - the nuclei of the solar spots increase and decrease [Macularum Solarium, creſcunt ac decreſcunt.], 409.
  - the nuclei of the solar spots have their own atmospheres [Macularum Solarium,ſuas habent atmoſphæras.], 409.
- The colour of cometary nuclei [Nucleorum cometicorum Color.], 435.
  - the form and shape of cometary nuclei [cometicorum forma & figura.], 350.
  - the duration of the nuclei and of the solar spots [& Macularum Solarium Duratio.], 409.
  - the rise and passing away of the nuclei and of the solar spots [Macularumq; Solarium ortus & interitus.], 409.

    - the method of recognising the motion of the nuclei [Motum cognoſcendi ratio.], 344.
- The comet of 1618 possessed irregular nuclei [Nucleos Cometa 1618 poſſedit irregulares.], 350.
- Not only the Author but others too have detected nuclei visible on the disc of the Sun [Nucleos in Solis diſco aſpectabiles non ſolùm Auctor, ſed & alii deprehenderunt.], 890.
- A very bright and remarkable nucleus was detected in the very head of the comet of 1664 [Nucleus clariſſimus & inſignis in ipſo capite Cometæ 1664 eſt deprehenſus.], 894.
    - the nucleus of the comet of 1618 finally broke up into several [Cometæ 1618 tandem in plures abiit.], 341.
    - the principal nucleus of comets: does it stand in the middle of the head? [Cometarum præcipuus, an in medio capitis conſiſtat ?], 435.
- The inner nucleus of the comet of 1661 went off in different directions [Nucleus interior Cometæ 1661, in diverſas partes abiit.], 721.

O.

- The obliquity and the curvature of the tail vary according to the diversity of the matter accompanying the comet [Obliquitas & caudæ curvatura, pro diverſitate materiæ Cometam concomitantis variatur.], 498.
- How obliquity and curvature are induced in the tails of comets according to the Author's opinion [Obliquitas & Curvitas quâ ratione caudis Cometar. ſecundùm ſententiam Auctoris inducitur.], 495.
- Every oblong body, and any flat one, has its own natural tiller [Oblongum corpus, & planiforme quodlibet, ſuum habet temonem naturalem.], 585.
- The obscurations of comets have many requisites [Obſcurationes Cometarum multa habent requiſita.], 551.
- The Author's singular observation of a certain solar spot [Obſervatio Auctoris ſingularis Maculæ cujusdam Solaris.], 424.
- An observation of a certain comet made by the Assyrians [Obſervatio Cometæ cujusdam ab Aſſiriis habita.], 795.
- An Icelandic observation of a comet [Obſervatio Cometæ Islandica.], 825.
- An observation of the comet of 1558 [Obſervatio Cometæ 1558.], 853.
    - observation of the comet of 1558 by the Prince of Hesse [Cometæ 1558 Principis Haſſiaci.], 854.
    - observation of the comet of 1577 made by Tycho [Cometæ 1577 à Tychone facta.], 857.
    - observation of the comet of 1580 by Graminaeus [Cometæ 1580 Graminæi.], 860.
    - observation of the comet of 1580 by Haggecius [Cometæ 1580 Haggecii.], 860.
    - observation of the comet of 1580 by Rivander [Cometæ 1580 Rivandri.], 859.

    - observation of the comet of 1596 made by Rothmann [Cometæ 1596 à Rothmanno facta.], 870.
    - observation of the comet of 1607 by Wendelen [Cometæ 1607 Wendelini.], 873.
    - observation of the comet of 1607 by Kepler [Cometæ 1607 Kepleri.], 871.
    - observation of the comet of 1618 made by Gassendi [Cometæ 1618 à Gaſſendo facta.], 876.
    - observation of the comet of 1618 made by Kepler [Cometæ 1618 à Keplero facta.], 880.
    - observation of the comet of 1618 by Remus Quietanus [Cometæ 1618 Remi Quietani.], 874.
- Even the more correct observations of the comet of 1618 waver [Obſervationes Cometæ 1618 etiam correctiores vacillant.], 625.
- The observation of the comet of 1652 made by Basirius at Aleppo [Obſervatio Cometæ 1652 Baſirii Alepi habita.], 325.
- The observation of the comet of 1652 by Cornelius Malvaticæus [Obſervatio Cometæ 1652 Cornelii Malvaticæi.], 325.
- The observation of the comet of 1652 by D. David Christiani [Obſervatio Cometæ 1652 D. Davidis Chriſtiani.], 325.
- Jungius's observation of the new star in the neck of Cetus [Obſervatio Jungii Stellæ novæ in collo Ceti.], 377.
- The Author's observations of the comet of 1652, made with various instruments [Obſervationes Auctoris Cometæ 1652, diverſis Inſtrumentis peractæ.], 5, 6, 7, 8, usque 15.
- The Author's observations of the new star in the neck of Cetus [Obſervationes Auctoris Stellæ novæ in collo Ceti.], 377.
- Observations of the comet of 1652 made with the optical tube [Obſervationes Cometæ 1652 Tubo optico habitæ], 326.
- Observations of the comet of 1661 made by the Author [Obſervationes Cometæ 1661 ab Auctore habitæ.], 725.
- Observations of the comet of 1661 [Obſervationes Cometæ 1661.], 416.
- Observations of comets: why are they to be undertaken? [Obſervationes Cometarum, cur ſint inſtituendæ ?], 17.
- Observations are to be made with various instruments [Obſervationes, diverſis ſunt peragendæ inſtrumentis.], 167.
- Not all observations are to be applied indiscriminately to the business of parallax [Obſervationes non promiscuè omnes, ad negotium parallacticum ſunt adhibendæ.], 181.
- The observations the Author used in the business of parallax [Obſervationes, quibus Auctor in negotio parallactico uſus.], 181.
- The requisites of observations [Obſervationum requiſita.], 139.

- Observers: why did they not always detect the same tail in the comet of 1652? [Obſervatores, cur non eandem ſemper in Cometâ 1652 caudam deprehenderint ?], 330.
- Observers are easily deceived in drawing the tails of comets [Obſervatores in delineandis Cometarum caudis facilè hallucinantur.], 331.
- The setting and rising of comets [Occaſus Cometarum & ortus.], 349.
- The encounter of comets is explained by examples [Occurſus Cometarum exemplis dilucidatur.], 652.
- Every extended thing has its own centre of gravity [Omnis res expanſa, ſuo gaudet gravitatis centro.], 420.
- The opinions of the philosophers on the motion of comets [Opiniones Philoſophorum de Cometarum motu.], 560.
- The various opinions of the Ancients on comets [Opiniones Veterum variæ de Cometis.], 351.
- It is proved that there is a vaporous orb around Jupiter and its companions [Orbem circa Jovem ejusq; Comites dari vaporoſum, probatur.], 370.
- It is proved that there is a vaporous orb around the planets [Orbem circa Planetas dari vaporoſum, probatur.], 368.
- All the heavenly bodies have their own vaporous orb [Orbem ſuum vaporoſum, univerſa habent corpora cœleſtia.], 371.
- It is proved that there is a vaporous orb around the inferior planets too [Orbem vaporoſum circa Planetas etiam inferiores dari, probatur.], 372.
- There are no real orbs in the heavens [Orbes in cœlo non dantur reales.], 352.
- The ratio of the great orb to the sphere of the fixed stars [Orbis magni ratio, ad Sphæram Stellarum fixarum.], 391.
- An orb thrown crosswise travels much more slowly than one thrown with its disc upright and its thickness turned toward its course [Orbis quando transverſum projicitur, multò fertur tardiùs, quàm ſi erecto diſco, craſſitie ſuâ curſui obversâ projicitur.], 675.
- The size and proportion of the orbs of the planets [Orbium Planetarum quantitas & proportio.], 713.
- The true origin of comets [Origo Cometarum vera.], 354.
- The origin and rise of the solar spots [Origo & Ortus Macularum Solarium.], 360.
- The rising and setting of comets [Ortus Cometarum & Occaſus.], 349.
- How the rising and setting of new stars comes about [Ortus & Occaſus novarum Stellarum quomodo fiat.], 391.
- Why does the rising of new stars occur more often in the Milky Way? [Ortus Stellarum novarum cur [?] ſæpiùs accidat in viâ lacteâ ?], 424.

P.

- Paler comets are for the most part higher than redder ones [Pallidiores Cometæ altiores plerumq́ue ſunt, rubicundioribus.], 389.

- The pallor and dimness of comets: where do they come from? [Pallor & Obſcuritas Cometarum unde ?], 431.
    - the pallor and the faintly livid hue of comets: where do they come from? [& Sublividitas Cometarum unde ?], 338.
- The section of the parabola: when it falls below the line of the tangent [Parabolæ Sectio, quando infra tangentis lineam incidit.], 680.
    - the section of the parabola: just as it never passes into an entirely straight line, so the motion of comets never becomes entirely straight [Sectio, quemadmodum in lineam omninò rectam nunquam tranſit, ſic motus Cometarum nunquam penitùs fit rectus.], 680.
    - the vertex of the parabola described by comets: when it falls below, and when above, the line of direction [Vertex à Cometis deſcripta, quando infra, & quando ſupra directionis lineam incidit.], 668.
    - the vertex of the parabola: when it goes above the line of direction [Vertex,quando ſupra directionis lineam incedit.], 680.
- How the parabola is described in a projection parallel to the horizon [Parabola, quâ ratione deſcribitur in projectione ad horizontem parallelâ.], 661.
- What a parabolic section is [Parabolica Sectio quid ſit.], 660.
- Projected and fired bodies advance with a parabolic motion [Parabolico motu progrediuntur projecta, & exploſa.], 660,664.
- Parabolic motion arises from two contrary motions [Parabolicus motus ex duobus motibus contrariis oritur.], 661.
    - parabolic motion also takes place in the air [motus in aêre etiam locum habet.], 659.
    - how parabolic motion behaves at the beginning and at the end [motus quomodo initiò & in fine ſe habeat.], 663.
- The final equation of parallax: how it is found [Parallaxeos æquatio ultima, quomodo invenitur.], 193.
    - investigation of the parallax of the comet of 1652 for December 23 [inveſtigatio Cometæ 1652 ad diem 23 Decembr.], 200, 201, 202 usque 209.
    - investigation of the parallax of the comet of 1652 for December 27 [inveſtigatio Cometæ 1652 ad diem 27 Decembr.], 224, 225 usque 253.
    - investigation of the parallax of the comet of 1652 for December 29 and 30 [inveſtigatio Cometæ 1652 ad diem 29 & 30 Decembr.], 260, 261 usque 27[?].
    - investigation of the parallax of the comet of 1652 for December 31 [inveſtigatio Cometæ 1652 ad diem 31 Decembr.], 274, 275 usque ad 280.
    - investigation of the parallax of the comet of 1653 for January 1 [inveſtigatio Cometæ 1653 ad diem 1 Januarii.], 280, 281, 282, 283, 284.

    - investigation of parallax: in what order it is to be undertaken [inveſtigatio, quo Ordine inſtituenda.], 228.
- Parallaxes require the most accurate observations, obtained with the most exquisite instruments [Parallaxes accuratiſſimas Obſervationes, exquiſitiſſimis Organis acquiſitas requirunt.], 139.
    - parallaxes of the comet of 1652 from the apparent and true declinations [Cometæ 1652 ex viſis & veris Declinationibus.], 295.
    - horizontal parallaxes of the comet of 1652 [Cometæ 1652 horizontales.], 286, 311, 312, 313.
    - the parallaxes of the comet of 1652: just as they gradually decreased, so this phenomenon too gradually rose higher [Cometæ 1652 quemadmodùm paullatim decrevére, ſic phænomenon etiam iſtud ſenſim altius evaſit.], 316.
    - the parallaxes of the comet of 1661 were explored by a short method [Cometæ 1661 compendioſâ viâ exploratæ ſunt.], 744.
    - to derive parallaxes properly is a great labour [debitè elicere, ingens eſt labor.], 164.
    - the method of deriving parallaxes from the vertical distances [eruendi, ex diſtantiis verticalibus, Methodus.], 744.
    - parallaxes and the distances of comets from the earth can be determined fairly accurately according to the Author's hypothesis, given exquisite observations [& Cometarum intervalla à terrâ, datis exquiſitis obſervationibus, ſatis accuratè ſecundùm Auctoris hypotheſin definiri poſſunt.], 750.
    - parallaxes are also investigated from the declinations and latitudes [ex Declinationibus & Latitudinibus quoque inveſtigantur.], 292.
    - the method of deriving parallaxes from the declinations and latitudes [ex Declinationibus & Latitudinibus eruendi Methodus.], 292.
- The Regiomontanian method of exploring parallaxes is very unreliable [Parallaxes explorandi methodus Regiomontana, admodùm eſt lubrica.], 611.
    - method of investigating horizontal parallaxes [horizontales inveſtigandi Methodus.], 286.
    - to investigate parallaxes in comets is more laborious than in new stars [in Cometis inveſtigare operoſiùs, quàm in novis Stellis.], 285.
    - parallaxes in comets are not explored by one and the same method [in Cometis non unâ eâdemq; ratione explorantur.], 744.
    - the business of determining parallaxes is most intricate [indagandi negotium eſt intricatiſſimum.], 177.
    - the method of investigating parallaxes when the comet stands in recession with respect to a star [inveſtigandi ratio, quando Cometa ad Stellam in receſſu verſatur.], 175.
    - by what route parallaxes are derived most accurately of all [quâ viâ omnium accuratiſſimè eruantur.], 166.

    - Tycho frequently deduced parallaxes by azimuths [Tycho per Azimutha frequenter deduxit.], 167.
    - the vertical parallaxes of the comet of 1577 can also be derived from Tycho's observations [verticales Cometæ 1577, ex Obſervationibus quoque erui poſſunt Tychonianis.], 286.
    - a different method of inquiring into vertical parallaxes [verticales diverſa inquirendi Methodus.], 288.
- With the parallaxes deduced by the Author's method, the seats of comets are demonstrated conclusively [Parallaxibus deductis, Auctoris Methodo, ſedes Cometarum demonſtrativè demonſtratur.], 168.
    - by parallaxes it is proved conclusively in what place the comet of 1652 stood each day [demonſtrativè probatur, quo loco omni die Cometa 1652 hæſerit.], 310.
    - nobody has devoted such careful effort to parallaxes as Tycho Brahe [nemo adeò ſollicitè dedit operam, ut Tycho Brahæus.], 138.
    - by parallaxes the genuine seat of comets is fully demonstrated [omninò demonſtratur genuina Cometarum ſedes.], 164.
- To reduce the parallax to the vertical and to find the prosthaphaeresis of the inclination is a task of the greatest labour [Parallaxin ad verticalem redigere,& proſthaphæreſin inclinationis invenire, res eſt maximi laboris.], 189.
    - Regiomontanus merely conjectured the parallax of the comet of 1472 [Cometæ 1472 Regiomontanus tantummodò auguratus eſt.], 610.
    - the method of deriving the parallax from two distances observed in one and the same quadrant [eruendi Modus ex duabus diſtantiis, in uno eodemq; quadrante obſervatis.], 256.
    - reduction to the vertical now increases, now diminishes the parallax [modò auget, modò minuit reductio ad verticalem.], 188.
    - how it is established from the Regiomontanian calculation that a parallax underlies observations [Obſervationibus ſubeſſe, unde ex calculo Regiomontano conſtet.], 303.
    - from what it is known with certainty that a parallax is present in a phenomenon [phænomeno ineſſe, ex quibus certò cognoſcitur.], 178.
- Equal or mean parallax [Parallaxis æqualis, ſeu media.], 178.
    - the parallax of altitude is more certain than the difference of parallaxes [altitudinis certior eſt, differentiâ parallaxium.], 199.
    - whether the parallax can be derived from wholly equal distances taken nevertheless at different times? [anne ex Diſtantiis omninò æqualibus, diverſo tamen tempore captis, erui poſſit ?], 215.
    - the parallax of the comet of 1582 [Cometæ 1582.], 620.
    - the parallax of the comet of 1618 [Cometæ 1618.], 628.

    - the parallax of the comet of 1652 was 52″ on January 4 [Cometæ 1652 die 4 Januarii 52″ extitit.], 311.
    - the parallax of the comet of 1652 was far smaller than the parallax of the Moon [Cometæ 1652 parallaxi Lunæ longè fuit minor.], 136.
    - the parallax of the comet of 1652 according to the Regiomontanian method [Cometæ 1652 ſecundùm Methodum Rogiomontanam.] [recte: Regiomontanam], 302, 303.
    - the parallax of the comet of 1664: by what method the Author explored it [Cometæ 1664, quâ ratione ab Auctore fuit explorata.], 756,757 & 758.
    - whether the parallax of comets is one or two minutes greater or smaller brings the Peripatetics little comfort [Cometarum, an uno, aut altero minuto major vel minor ſit, Peripateticis parùm adfert ſolatii.], 211.
    - parallax makes the distance from a fixed star greater if the fixed star stands higher than the phenomenon, under the same vertical [Diſtantiam à Fixâ reddit majorem, ſi fixa altior exiſtat phænomeno, ſub eodem verticali.], 173.
    - the parallax of different horizons is not deduced from just any observations [diverſorum Horizontum, non ex quibusvis Obſervationibus deducitur.], 310.
    - how great the parallax of different horizons would have been had the comet of 1652 stood in the air [diverſorum Horizontum, quanta fuisſet, exiſtente Cometâ 1652 in aëre.], 154.
- Fictitious parallax [Parallaxis ficta.], 172, 178.
    - the difference between the parallax of the orbit and the vertical parallax [Orbitæ & verticalis differentia.], 188.
    - the parallax of the orbit and the vertical parallax: when they differ scarcely at all [Orbitæ & Verticalis, quando vix quicquam differunt.], 190.
    - the parallax of the orbit: what is it? [Orbitæ quid eſt ?], 190.
    - the parallax of the orbit: how it becomes known [Orbitæ quomodo innoteſcat.], 174.
- Parallax settles the principal questions about comets [Parallaxis, præcipuas de Cometis dirimit Quæſtiones.], 165.
    - parallax first equated [primò coæquata.], 19[?].
    - the parallax that Regiomontanus assigned to the comet of 1472 [quam RegiomontanusCometæ 1472 adſcripſit.], 603.
    - when a parallax underlies a phenomenon [quando phænomeno ſubſit.], 183.
    - how great the parallax between Paris and Danzig would have been had the comet of 1652 stood in the aerial region [quanta fuisſet inter Pariſios & Dantiscum, Cometâ 1652 exiſtente in regione aëreâ.], 154.

- in which observations there is parallax [quibus Obſervationibus ineſt.], 305.
- in what place parallax is imperceptible [quo loco eſt imperceptibilis.], 173.
- parallax with respect to the disc of comets: from what it arises [ratione diſci Cometarum, unde exoriatur.], 708.
- a sensible parallax was not present in the comet of 1652 on December 31 [ſenſibilis Cometæ 1652, die 31 Decembr. haud adfuit.], 274.
- vertical parallax: from which observations it is derived [verticalis, ex quibus eruatur Obſervationibus.], 17[?].
- the vertical parallax is always greater than the parallax of the orbit [verticalis perpetuò eſt major parallaxi Orbitæ.], 190.
- vertical parallax: what is it? [verticalis quid eſt ?], 288.
- reduced vertical parallax: how it is to be limited [verticalis reducta, quomodo limitanda.], 191.
- whether some parallax inheres in the observations? [utrùm aliqua obſervationibus inhæreat ?], 226.
- whether a parallax applies to the comet of 1652? [utrùm Cometæ 1652 competat ?], 138.

- A particular axiom of parallaxes, for certain cases [Parallaxium axioma peculare, ad certos caſus.] [recte: peculiare], 225.
  - axioms of parallaxes with respect to addition and subtraction, when fixed stars lie under the orbit itself or near it [axiomata ratione additionis & ſubtractionis, quando Stellæ fixæ ſub ipsâ orbitâ, vel propè eam reſident.], 194, 195.
  - not all observations can be applied equally conveniently to the calculation of parallaxes [Calculo non æque omnes commodè adhiberi poſſunt obſervationes.], 167.
  - calculation of parallaxes from altitudes [Calculus ex altitudinibus.], 288.
  - calculation of parallaxes: what it requires beforehand [Calculus, quænam in anteceſſum requirit.], 139.
  - a new method of deriving the difference of parallaxes [Differentiam eruendi nova ratio.], 199.
  - error of parallaxes: by what means it is noticed [error, quâ ratione animadvertitur.], 168.
  - axioms of parallaxes derived from declinations and latitudes [ex Declinationibus & Latitudinibus erutarum axiomata.], 293.
  - investigation of the parallaxes of the comet of 1652 for December 31 and January 1 according to the Regiomontanian method [inveſtigatio Cometæ 1652 ad diem 31 Decemb. & 1 Januarii ſecundùm Methodum Regiomontanam.], 307.
  - the business of parallaxes requires most accurate observations [negotium obſervationes requirit accuratiſſimas.], 211.

    - the business of parallaxes: how it is to be undertaken if a phenomenon possesses parallax together with a proper motion [negotium, ſi phænomenon cum motu proprio parallaxin ſimul posſideat, quomodo inſtituendum.], 170.
    - rules of parallaxes [Regulæ.], 177.
    - theorems of parallaxes [Theoremata.], 169, 170.
    - the variation of parallaxes, for comets standing at a distance of 10 semidiameters of the Earth, is confirmed by a diagram [Variatio, Cometis in Diſtantiâ 10 Semid. Terræ exiſtentibus, comprobatur Schemate.], 160.
- The perigee and greatest velocity of the comet of 1661 according to the Author's calculation [Perigæum & maxima velocitas Cometæ 1661 ſecundùm calculum Auctoris.], 781.
    - the perigee and greatest velocity of the comet of 1664 according to the Author's calculation [& maxima velocitas Cometæ 1664 juxta calculum Auctoris.], 781.
    - the perigee and greatest velocity of the comet of 1665 according to the Author's calculation [& maxima velocitas Cometæ 1665 ſecundùm calculum Auctoris.], 781.
- The Peripatetics reject observations so as not to be disturbed in their preconceived opinion [Peripatetici, ne in præconceptâ turbentur opinione, obſervationes detrectant.], 328.
- Some of the Peripatetics imagine comets beyond 2580 miles [Peripateticorum alii, Cometas ultra 2580 Mill. fingunt.], 160.
    - the opinion of the Peripatetics on the tails of comets [de Cometarum Caudis opinio.], 459, 469.
    - the view of the Peripatetics on cometary diameters [de Diametris cometicis ſententia.], 347.
    - the opinion of the Peripatetics on the vibration and fluctuation of tails [de Vibratione & Fluctuatione Caudarum opinio.], 511.
    - in the judgement of the Peripatetics one comet or another can be wandering and erratic, although in reality it is most regular [judicio Cometa alius esſe poteſt vagabundus & erraticus; cùm tamen reverà ſit regularisſimus.], 663.
    - some Peripatetics raise comets a little higher to avoid excessive absurdities [nonnulli nimias abſurditates evitandi gratia Cometas paulò altius attollunt.], 157.
- Had the School not stood in the way, we would indeed by now have advanced further in astronomical speculations [Schola niſi obſtitisſet, plus ultra equidem,in SpeculationibusAſtronomicis jam pervenisſem9.], 437.
- That the Peripatetics can in no way keep comets suspended in the air [Peripateticos, Cometas in aëre ſuſtinere nullo modo posſe.], 758.

    - that the Peripatetics cannot avoid all the incongruities, even if the Author removes comets 2580 miles from the Earth, is clearly demonstrated by a diagram [inconvenientias omnes evitare haud posſe, licet Auctor Cometas à Terrâ 2580 Mill. removeat, Schemate luculenter demonſtratur.], 157.
- How the heights of the perpendiculars are found in the theory of comets [Perpendiculorum altitudines, quomodo in Theoriâ Cometarum inveniuntur.], 596.
    - the perpendiculars from the path to the plane of the ecliptic follow an altogether different rule from that of the latitudes [ex Trajectoriâ ad planum Eclipticæ alia prorsùs eſt ratio, quàm latitudinum.], 767.
- The perpendicular of the comet of 1664 from the Sun falls now one way, now another, according to the curvature of the path [Perpendiculum Cometæ 1664 ex Sole, pro incurvatione Trajectoriæ aliter atque aliter incidit.], 760.
    - the perpendicular from the Sun to the comet usually makes a more acute angle with the path [ex Sole ad Cometam cum Trajectoriâ acutiorem plerumque conſtituit angulum.], 672.
    - the shorter the perpendicular from the Sun to the path, the faster the motion [ex Sole ad Trajectoriam quò brevius, eò motus velocior eſt.], 705.
    - at what place of the ecliptic did the perpendicular from the Sun to the path fall in the comet of 1664? [ex Sole ad Trajectoriam, quo loco Eclipticæ in Cometâ 1664 incidit ?], 759.
- Although the phenomena of a comet may seem utterly absurd, they are nevertheless demonstrated by a diagram [Phænomena alicujus Cometæ licet abſurdiſſima videantur; Schemate tamen demonſtrantur.], 633.
    - the phenomena of tails are explained more successfully by disc-shaped bodies than by glass spheres [Caudarum feliciùs per corpora explicantur diſcea quàm per Sphæras vitreas.], 475.
    - the phenomena of tails cannot properly be saved by a glass sphere [Caudarum per Sphæram vitream conſervari commodè haud posſunt.], 475.
    - by what means the phenomena of tails are best saved of all [Caudarum, quâ ratione omnium optimè ſalventur.], 475.
- The phenomena of the comet of 1590 are correctly demonstrated by calculation and a diagram [Phænomena Cometæ 1590 ex Calculo & Schemate rectè demonſtrantur.], 621.
    - the phenomena of the comet of 1618 can in no way be established by eccentrics [Cometæ 1618, per eccentricos nullâ ratione evincuntur.], 629.
    - all the phenomena of comets can be saved successfully by the path [Cometarum univerſa,feliciter Trajectoriâ ſalvari posſunt.], 637.

- in comets, phenomena most to be wondered at are found when the Earth passes beyond the trace [in Cometis maximè demiranda deprehenduntur, Terrâ veſtigium tranſcendente.], 635.
- phenomena equal to those of the Moon and the Earth: how many the Sun can produce in one year [Lunæ Terræq́; æqualia, quot uno anno Sol progignere poſſit.], 404.
- no phenomena except spots are detected on the Earth from the Moon [nulla, præter Maculas ex Lunâ in Terrâ deprehenduntur.], 369.
- when and where the phenomena appear to keep a station [quando, & ubi ſtationem celebrare videntur.], 607.
- how the phenomena are best saved of all [quomodo omnium optimè ſalventur.], 621.
- comets are the rarest phenomena of the heavens [ſunt cœli rariſſima, Cometæ.], 436.
- all the phenomena are best demonstrated by the Author's hypothesis [univerſa, Auctoris hypotheſi optimè demonſtrantur.], 588.
- all the phenomena are saved more fittingly on a path partly curved than on one stretched out entirely in a straight line [univerſa convenientiùs in trajectoriâ ſalvantur partim incurvatâ, quàm indirectum prorsùs extensâ.], 760.
- all the phenomena are best saved by trajectory motion, but by circular motion in no way [univerſa per motum trajectorium optimè,per circularem verò nullo modo conſervantur.], 588,589.

- A remarkable phenomenon of the comet of 1618 [Phænomenon inſigne Cometæ 1618.], 456.
  - a remarkable phenomenon of the tail observed in the comet of 1577 [Caudæ inſigne in Cometâ 1577 deprehenſum.], 856.
  - a singular phenomenon of the tail, of P. Horatius Crassus, observed in the comet of 1618 [Caudæ ſingulare P. Horatii Craſſi, in Cometâ 1618 deprehenſum,], 881.
  - a singular phenomenon of the tail, observed by Gemma [Caudæ ſingulare, à Gemmâ obſervatum.], 453.
  - a very notable phenomenon concerning the solar faculae, shadows and luculae [circa Faculas,Umbras atq́ue Luculas Solares valdè notabile.], 479.
  - a quite singular phenomenon in the Moon, detected by the Author [in Lunâ admodùm ſingulare, ab Auctore deprehenſum.], 363.
  - a very wonderful phenomenon seen in the Moon [in Lunâ conſpectum valdè mirum.], 367.
  - a remarkable phenomenon detected in the lunar eclipse of the year 1635 [inſigne, in deliquio Lunari an. 1635 detectum.], 365.
  - when a phenomenon appears stationary [quando videtur ſtationarium.], 638.

    - how a phenomenon can come into our view unexpectedly [quâ ratione in conſpectum nobis ex inopinato venire poſſit.], 710.
- The method of philosophizing about things perceived by the senses [Philoſophandi in rebus ſenſibilibus ratio.], 354.
- The duty of the philosopher in examining natural things [Philoſophi officium,in ſcrutandis rebus naturalibus.], 353, 423.
- It is incumbent on the philosopher to refer his doctrines to the evidence of the senses [Philoſopho incumbit, ut dogmata ſua in ſenſuum referat evidentiam.], 343.
- The various opinions of philosophers on the operating and expelling cause of comets [Philoſophorum de causâ Cometarum operante & expellente opiniones variæ.], 392.
    - the various opinions of philosophers on the tails of comets: in what they agree and in what they differ [opiniones variæ de Cometarum caudis in quibus conveniant, & in quibus discrepent.], 475.
    - the opinions of the ancient as well as the more recent philosophers on the motion of comets [tam Veterum, quàm Recentiorum de Cometarum motu opiniones.], 560.
- It does not befit philosophers to take refuge in divine omnipotence, and also in occult qualities, before they have attempted something in the matter [Philoſophos ad omnipotentiam divinam,tùm occultasqualitates confugere priùs non decet, quàm aliquid in eâ re tentaverint.], 643.
- The notes of Phocylides [Johannes Phocylides Holwarda] on the new star that arose in the neck of Cetus [Phocylidis de novâ Stellâ in collo Ceti exortâ annotationes.], 376.
- Natural things demand physical explanations [Phyſicas rationes expoſcunt res naturales.], 643.
- A ball thrown straight up from a moving hand falls back into the same hand [Pila directè è commotâ manu projecta in altum, in eandem manum recidit.], 663.
- In fish and birds the tail serves as a rudder [Piſcibus atque avibus, Cauda inſtar temonis eſt.], 587.
- In fish the fins, and in birds the wings, serve as oars [Piſcibus pinnæ,& avibus alæ,inſtar remorum ſunt.], 587.
- The various species of pitheus comets [Pitheorum Cometarum variæ ſpecies.], 442.
- The pitheus comet [Pitheus Cometa.], 439.
- Why do the planets rotate about an axis? [Planetæ, cur circa axem rotentur ?], 430.
    - the planets are subject to generation and corruption with respect to certain parts [generationi, & corruptioni ſunt obnoxii, quoad certas partes.], 368.

- the planets, and the fixed stars too, according to the Peripatetics, advance at a [?] pace [nec non Fixæ, cele[?]rimo, ſecundùm Peripateticos, incedunt gradu.], 706.
- notwithstanding their inclination, the planets move under a great circle [non obſtante inclinatione, ſub circulo moventur maximo.], 135.
- just as all the primary planets acknowledge the Sun as their centre, so the comets too regard it in their own way [primarii omnes, ſicuti Solem pro centro agnoſcunt, ſicetiam Cometæ ſuo modo eum reſpiciunt.], 701.
- with what velocity the planets are carried in their orbits [quantâ velocitate in ſuis orbibus ferantur.], 703.
- by what means and in what order the planets take back and draw in their exhalations [quâ ratione,& quo ordine ſuas repetunt,atque attrahunt exſpirationes.], 386.
- which planets are subject to mutual obscurations [quinam mutuis Obſcurationibus ſint obnoxii.], 549.
- the nearer the planets are to the centre of the universe, the faster they are [quò Centro univerſi ſunt propiores, eò ſunt velociores.], 137.
- all the planets there are acknowledge the Sun as their centre [quotquot ſunt, Solem pro centro agnoſcunt.], 385.
- in respect of their motion, the planets have not yet been carried up to the highest trace [ratione motûs, ad ſummum veſtigium evecti nondum ſunt.], 704.
- not all the planets are able to shadow one another [ſe mutuò inumbrare, omnes non valent.], 549.
- the planets too have their own vaporous orbs [ſuos quoque habent Orbes vaporoſos.], 368.

- Not all the atmospheres of the planets complete their revolutions equally fast and in an equal space of time [Planetarum atmoſphæræ, non univerſæ æque velociter, atque æquali temporis ſpatio, circumgyrationes ſuas peragunt.], 695.
  - whether the effluvia of the planets can produce some parallax for us? [effluvia, an diverſitatemaliquam adſpectûs inducere nobis posſint ?], 429.
- How the shadowing of planets and of comets differs [Planet. & Cometarū inumbratio quomodo differt.], 549.
  - generations and changes in the planets are not easily perceived by us [generationes, & vicisſitudines in Planetis haud facilè à nobis percipiuntur.], 370.
  - the distances of the planets according to the Author's hypothesis, set out in a table [intervalla, ſecundùm Auctoris hypotheſin in Tabellam redacta.], 713.

    - the size of the planets, and their ratio to the Earth [Magnitudo, eorumq́; ad Terram ratio.], 395,396.
    - the matter of the planets [Materia.], 368.
    - how far the matter or exhalation of the planets can be driven [Materia ſive Halitus,quousq́ue poteſt propelli.], 386.
    - what is required for the planets to be obscured [Obſcurandorum requiſita.], 548, 549.
    - the manner of the obscuration of the planets [Obſcurationis ratio.], 549.
    - why are the alterations of all the planets not detected as they are in the Sun? [omnium alterationes, cur non æq́ue ac in Sole deprehendantur ?], 368.
    - by what means the effluvia and overflowings of all the planets come together into one cometary body [omnium effluvia, atq́ue exundationes, quâ ratione in unum coëant Corpus cometicum.], 384.
- How great are the orbs of the planets according to Tycho? [Planetarum orbes quantæ juxta Tychonem ſunt magnitudinis ?], 714.
    - the order of the planets, placed both in perigee and in apogee [Ordo tam in Perigæo, quàm Apogæo conſtitutorum.], 314.
    - each planet sometimes nourishes its own spots [quilibet nonnunquam ſuas maculas alit.], 700.
    - the appearance of certain planets during the comet of 1661 [quorundam facies, exiſtente Cometâ 1661.], 721.
    - each of the planets has its own particular colour, which their effluvia imitate [ſinguli, peculiarem habent colorem, quem eorum effluvia æmulantur.], 388.
    - the magnitude of the apparent diameter of each planet, as seen from the fixed stars [ſingulorum apparentis Diametri Magnitudo, ex Fixis ſpectata.], 398.
    - the velocity of the planets: how great it is in the Author's view [velocitas, quanta exiſtit ex mente Auctoris.], 703.
    - the velocity of the planets according to Tycho and Kepler [velocitas ſecundùm Tychonem & Kepplerum.], 703.
    - the shadows of the planets are smaller than their intervals [Umbræ, minores ſunt eorum intervallis.], 549.
- The generation of comets takes nothing at all away from the planets [Planetis, Generatio Cometarum nil penitùs derogat.], 436.
- Every flat and oblong body has its own natural tiller [Planiforme, & oblongum corpus quodlibet, ſuum habet temonem naturalem.], 585.
- Pliny the Elder's classification of comets [Plinii diſtinctio Cometarum.], 438.

- The many observations of the comet of 1652 made here and there are of no value [Plurimæ Obſervationes Cometæ 1652 paſſim habitæ, nullius ſunt pretii.], 311.
- The Pole Star once vanished [Polaris Stella aliquando evanuit.], 374.
- The elevation of the pole, and the difference of meridians between Digne and Danzig [Poli Elevatio, & Differentia Meridianorum inter Diniam & Dantiſcum.], 156.
    - the elevation of the pole at Paris [Elevatio Pariſienſis.], 151.
    - the elevation of the pole at Königsberg, corrected [Elevatio Regiomontana correcta.], 156.
- A great weight can be moved by a small force [Pondus magnum, ab exiguâ moveri poteſt virtute.], 581.
    - the nearer the weight stands to the fulcrum, the more easily it is lifted [quantò propiùs fulcimento adſtat, tantò faciliùs attollitur.], 578.
- Posterity, with God and [?], will without doubt discover a great many things in comets [Poſteritas, cum DEO & di[[c/e]], plurima in Cometis deteget ſine dubio.], 704.
- The power of the wheel and axle gives no bad account of the working of the helm [Potentia axis in peritrochio, operationem clavi haud malè explicat.], 582.
- The power of moving: what is it? [Potentia movendi quænam ?], 578.
- The moving power is applied not to the rudder but to the tiller [Potentia movens, non ad gubernaculum, ſed ad temonem accidit.], 580.
- Some very notable preliminary remarks about parallaxes [Præmonitiones quædam circa parallaxes, valdè notabiles.], 171.
- The principles of motion [Principia motûs.], 571.
    - there is no arguing with those who deny principles that are beyond all exception [omni exceptione majora qui negant, contra illos non eſt diſputandum.], 759.
- The principles of optics [Principia optica.], 575.
- The *Mantissa* of the *Prodromus*: why did the Author write it? [Prodromi Mantiſſa, cur ab Auctore conſcripta ?], 755.
- What does the cometary *Prodromus* published by the Author contain? [Prodromus cometicus ab Auctore editus quid continet ?], 755.
- The projections of comets that occur in the atmosphere: how they are distinguished [Projectiones Cometarum, quæ in atmoſphærâ contingunt, quomodo diſtinguantur.], 671.
- Everything thrown and fired advances with a parabolic motion [Projectum & exploſum omne, motu progreditur parabolico.], 660.
    - where it necessarily tends [quò neceſſariò tendat.], 662.
- The more vehement the projection, the more distant the vertex of the parabola is from the point of separation [Projectio, quò vehementior, eò remotior eſt vertex parabolæ à puncto ſeparationis.], 661.

- The proportion of speed: is it always the same in all comets? [Proportio celeritatis, an in omnibus Cometis ſemper ſit eadem ?], 689.
    - the proportion of the motion of comets as well as of planets is always the same on every hypothesis [motus tàm Cometarum, quàm Planetarum ex omni hypotheſi ſemper eſt eadem.], 703.
- How the prosthaphaereses are to be applied to parallaxes is shown graphically by the Author [Proſthaphæreſes, quâ ratione parallaxibus ſint applicandæ, graphicè ab Auctore declaratur.], 175.
- The method of computing the first prosthaphaeresis of the inclination [Proſthaphæreſin inclinationis primam ſupputandi Methodus.], 192.
- Prosthaphaeresis and equation of the parallax [Proſthaphæreſis & æquatio parallaxeos.], 188.
    - the prosthaphaeresis of the inclination [Inclinationis.], 172.
    - the prosthaphaereses of the inclination are sometimes applied to the parallaxes of the orbit in the contrary way [Inclinationis nonnunquam modo contrario parallaxibus orbitæ applicantur.], 231.
- The prosthaphaeresis of the inclination: of how many kinds it is [Proſthaphæreſis Inclinationis quotuplex.], 191.
    - when it is to be added, and when subtracted [quando eſt addenda, quandove ſubtrahenda.], 194.
- To recognise correctly the properties of prosthaphaereses in parallaxes is no slight matter [Proſthaphæreſium affectiones in parallaxibus ritè dignoſcere, non eſt res leviuſcula.], 231.
- Pseudo-comets are merely chasmata and aetherial meteors that are wrongly called comets [Pſeudo-Cometæ ſunt tantùm Chaſmata & Meteora ætherea, quæ perperam Cometæ vocantur.], 387.
- The place and manner of generating pseudo-comets [Pſeudo-Cometarum generandi Locus & ratio.], 387.
- The matter of pseudo-comets: what is it like? [Pſeudo-Cometarum Materia qualis eſt ?], 387.
- Puteanus's opinion on the tails of comets [Puteani de Cometarum Caudis ſententia.], 470.
- Pyramidal and pointed comets are the most frequent of all [Pyramidati Cometæ, & Cuſpidati, omnium ſunt frequentiſſimi.], 450.
- The pyramidal comet [Pyramidatus Cometa.], 450.

Q.

- Which part of the earth is more fertile in spots [Quænam terræ pars Maculis eſt fœcundior.], 369.
- Parallax settles the principal questions about comets [Quæſtiones de Cometis præcipuas, parallaxis dirimit.], 165.
- Various questions about the trajection of comets [Quæſtiones de Trajectione Cometarum variæ.], 659.
- The square comet [Quadratus Cometa.], 440, 448.

- What horrible leaps, in longitude and latitude, a comet at a distance of 20 miles would show [Quales horribiles ſaltus, ratione Longit. & Latit. Cometa in diſtantiâ 20 Mill. oſtenderet.], 148.
- In how long a time someone would have gone around the comet of 1652 [Quanto tempore quis Cometam 1652 circumivisſet.], 334.
- Whatever is moved impresses its motion on all the things that it carries [Quicquid movetur, motum ſuum imprimit rebus omnibus, quas ſuſtentat.], 664.

R.

- The rays of comets: why do they not always point entirely straight? [Radii Cometarum, cur non ſemper in directum omninò vergant ?], 472.
- Rays in the rarer matter of the head: how they are refracted and reflected [Radii in Materiâ rariori Capitis, quomodo refringantur & reflectantur.], 502.
- Perpendicular rays are the strongest of all [Radii perpendiculares, omnium ſunt fortisſimi.], 575.
- The Sun's rays are not stopped in the aether [Radii Solares in æthere non ſiſtuntur.], 471,475.
- The Sun's rays are stopped in a denser medium [Radii Solares in medio ſiſtuntur denſiori.], 477.
- All the Sun's rays: they do not always proceed equally and at wholly similar angles of inclination and reflection [Radii Solares omnes, non æqualiter ſemper & ſub ſimilibus planè inclinationis & reflexionis angulis progrediuntur.], 502.
- The Sun's rays: by what means they are tinged with colours [Radii Solares, quâ ratione coloribus tingantur.], 515.
- The Sun's rays: by what means they are bent through the head of the comet [Radii Solares,quâ ratione per Cometæ Caput incurventur.], 501.
- The Sun's rays: how they are refracted from the perpendicular [Radii Solares, quomodo à perpendiculo refringantur.], 502.
- The more vivid and the stronger the Sun's rays are, and the more ample the matter accompanying the comet, the greater and the longer the tail [Radii Solares, quò ſunt vividiores, fortioresq;, atque Materia Cometam concomitans amplior, eò Cauda eſt major, atque longior.], 544.
- The direct action of rays is far stronger than the oblique [Radiorum actio directa,fortior longè eſt, obliquâ.], 575.
- The reflection and refraction of the Sun's rays in the cometary head [Radiorum Solarium in Capite cometico reflexio & refractio.], 502.
- A ray falling at a right angle proceeds unrefracted [Radius ad angulum rectum incidens, irrefractus procedit.], 501.
- The radius does not accomplish much in exploring parallaxes [Radius, in explorandis parallaxibus haud multùm præſtat.], 611.
- Arguments for the circular motion of comets [Rationes pro Motu Cometarum circulari.], 560.

- The moderns were more attentive in recording the phenomena of comets [Recentiores in annotandis Cometarum phænomenis fuêre attentiores.], 793.
- The reciprocating motion of comets is explained by a diagram [Reciprocatorius motus Cometarum Schemate declaratur.], 709.
- Reduction to the vertical now increases, now diminishes the parallax [Reductio ad verticalem, parallaxin modò auget, modò minuit.], 188.
- In the calculation of parallaxes we sometimes have no need of reduction to the orbit [Reductione ad Orbitam in Calculo parallaxium interdum non opus habemus.], 246.
- The method of reduction when the fixed stars stand at a right angle [Reductionis Modus, quando Fixæ ſub angulo exiſtunt normali.], 229.
- How the refraction and bending of rays come about in the head of comets [Refractio & Incurvatio radiorum in Cometarum capite quómodo fiat.], 502.
- How the refraction and reverberation of rays come about in the rarer matter of the head [Refractio & reverberatio radiorum, in Materiâ capitis rariori quomodo fit.], 502.
- In the aether there is no refraction at all [Refractio in æthere prorſus datur nulla.], 370.
- Refraction in comets: when it is to be applied [Refractio in Cometis, quando adhibenda.], 256.
- Refraction raises the phenomenon [Refractio phænomenon attollit.], 256.
- Some say that refraction is the cause of the curving [Refractionem nonnulli cauſam incurvationis dicunt.], 494.
- What refractions are to be applied to comets [Refractiones Cometis, quales ſunt adhibendæ.], 257.
- The optical axioms of refraction [Refractionis axiomata optica.], 497.
- Table of cometary refractions [Refractionum cometicarum Tabula.], 257.
- It is demonstrated that Regiomontanus's parallactic calculation is unsteady [Regiomontani Calculum parallacticum vacillare, demonſtratur.], 307.
- Very many people imagined Regiomontanus's comet to be in the air [Regiomontani Cometam plurimi aêreum finxerunt.], 601.
- Regiomontanus's observation of the comet of 1472 [Regiomontani Obſervatio Cometæ 1472.], 838.
- Regiomontanus deduced the parallax of the comet of 1472 the wrong way round [Regiomontanus parallaxin Cometæ 1472 præpoſterè deduxit.], 610.
- Regiomontanus: a very unreliable method of deriving parallaxes [Regiomontanus Modus parallaxes eruendi admodùm lubricus.], 295,296, 307.
- Regiomontanus: his method of detecting parallaxes [Regiomontanus parallaxes detegendi Modus.], 295.

- Regiomontanus: with what instrument he used to make his observations [Regiomontanus, quo inſtrumento obſervationes peragere ſolitus.], 611.
- Rules by which one can tell whether the deviation prevails? [Regulæ,ex quibus dignoſcitur,utrùm deviatio prævaleat ?], 567.
- Remus Quietanus's observation of the comet of 1618 [Remi Quietani Obſervatio Cometæ 1618.], 874.
- Those of both the planets and the comets that are more remote from the Sun retard their motion, while those nearer accelerate it [Remotiores à Sole, tàm Planetarum, quàm Cometarum retardant, viciniores verò motum accelerant.], 705.
- What is required for obscuring stars [Requiſita ad obſcurandas Stellas.], 548, 549.
- What is required for obscuring planets [Requiſita ad obſcurandos Planetas.], 548, 549.
- What is exceedingly necessary for making accurate observations [Requiſita ad peragendas accuratè obſervationes perquàm neceſſaria.], 139.
- Resistance impedes motion [Reſiſtentia impedit motum.], 571.
- The greater the resistance, the more difficult and the slower the motion [Reſiſtentia, quò eſt major, eò motus eſt difficilior, tardiorq́;.], 584.
- Natural things demand physical explanations [Res naturales, phyſicas expoſcunt rationes.], 643.
- Any thing tends to remain in the state it is in, unless it is hindered by a destroying cause [Res quælibet tendit ad permanendum in eo ſtatu, in quo eſt, niſi causâ deſtruente impediatur.], 648.
- Earthly things can deviate somewhat from straight motion [Res terreſtres deviare nonnihil à motu recto poſſunt.], 587.
- The retardation of comets: where does it come from? [Retardatio Cometarum unde ?], 635,657 & 658.
- The cause and reason of the retardation or acceleration of the motion of both planets and comets [Retardationis, ſeu accelerationis motûs tàm Planetarum quàm Cometarum cauſa atq́ue ratio.], 705.
- The retrogression of comets sometimes occurs around opposition to the Sun [Retrogreſſio Cometarum fit quandoq́ue circa oppoſitionem Solis.], 640.
- The opinion of Riccioli and Grimaldi on tails and their appearances [Riccioli & Grimaldi de caudis earumq́; apparentiis ſententia.], 473.
- Rivander's observation of the comet of 1580 [Rivandri Obſervatio Cometæ 1580.], 859.
- A comet in the form of a rhomphaea [Romphææ inſtar Cometa.], 447.
- The opinion of Rothmann and Riccioli on the place and seat of comets [Rothmanni & Riccioli de Cometarum Loco & Sede ſententia.], 318.
- The opinion of Rothmann and Seneca on the tails of comets [Rothmanni & Senecæ de Cometarum Caudis ſententia.], 469.

- Rothmann's observation of the comet of 1585 [Rothmanni Obſervatio Cometæ 1585.], 867.
- Rothmann's observation of the comet of 1596 [Rothmanni Obſervatio Cometæ 1596.], 870.
- Ruddier comets are mostly nearer the Earth than paler ones [Rubicundiores Cometæ, terræ plerumque ſunt propiores pallidioribus.], 389.
- Ruddier comets: when they appear [Rubicundiores Cometæ, quando appareant.], 515.

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- Arrows: why are they fitted with feathers? [Sagittæ, cur plumis armentur ?], 586.
- Arrows: by what means they always follow a straight motion [Sagittæ, quâ ratione motum ſemper proſequantur rectum.], 586.
- The satellites of Jupiter: why do they appear now larger, now smaller? [Satellites Jovis, cur modò majores, modò minores appareant ?], 370.
- The size of the little handles of Saturn [Saturni Anſularum Magnitudo.], 372.
    - the arms of Saturn: how great they are [brachia, quantæ ſunt Magnitudinis.], 394.
    - the size of Saturn's companion as seen from Saturn, and its distance [Comitis,ex Saturno viſi Quantitas,& Diſtantia.], 399.
    - the size of Saturn's companion [Comitis Magnitudo.], 394.
    - the size of Saturn and of its arms [ejusq; brachiorumMagnitudo.], 397.
    - the distance of the companions of Saturn and of Jupiter [Jovisq; Comitum Diſtantia.], 397.
    - the velocity of the moons of Saturn and of Jupiter [Jovisq; Lunarum velocitas.], 372.
    - the size of the apparent atmosphere of Saturn and of Jupiter [Jovisq; atmoſphæræ apparentis Magnitudo.], 387.
    - the companions of Saturn and of Jupiter exert the greatest forces in driving out exhalations [Jovisq; Comites, maximas in extrudendis exhalationibus exſerunt vires.], 371.
    - the sizes of the companions of Saturn and of Jupiter according to the hypothesis of Kepler and of the Author [Jovisq; Comitum Magnitudines, ſecundùm hypotheſin Keppleri & Auctoris.], 397.
    - the semidiameter of Saturn's sphere [Sphæræ Semidiameter.], 714.
- No comet was ever slower than Saturn [Saturno nullus Cometa tardior extitit.], 704.
- Saturn, according to Tycho, can obscure certain fixed stars but cannot hide them completely [Saturnus, juxta Tychonem, Fixas quasdam obſcurare, ſed non planè occultare poteſt.], 549.

    - how many miles Saturn covers by the motion of the first mobile in the space of one second [quot milliaria motu primi mobilis, unius ſcrupuli ſecundi ſpatio conficit.], 703,706.
- Scheiner's remarkable observation of a certain sunspot [Scheineri, inſignis Obſervatio cujusdam Maculæ Solaris.], 479.
- The judgement of Scheiner and Kircher on the atmosphere of the Moon [Scheineri & Kircheri judicium, de Lunæ atmoſphærâ.], 366.
- The diagram of the comet of 1664 answers the observations most exactly, but only with the path given as curved [Schema Cometæ 1664 exactiſſimè obſervationibus reſpondet, ſed datâ Trajectoriâ incurvatâ.], 760.
    - a diagram explaining the motion of comets [Cometarum motum declarans.], 571.
    - the diagram and the calculation of the comet of 1661 agree exceedingly well with the observations [& Calculus Cometæ 1661 cum Obſervationibus apprimè concordant.], 750.
- The movement and steering of a ship are explained by a diagram [Schemate, commotio & directio navis declaratur.], 579.
- An explanation of Regiomontanus's diagram for computing parallaxes [Schematis Regiomontani, ad parallaxes computandas dilucidatio.], 299.
- A diagram showing the path of inclination of certain comets, and also the interval between the comet and the Sun, as well as the angle of the path and the lines of sight drawn out from the Sun [Schema viam inclinationis quorundam Cometarum, nec non intervallum inter Cometam & Solem, ut & angulum Trajectoriæ & viſorias ex Sole eductas exhibens.], 687.
- The twinkling and fluctuation of tails: where do they come from? [Scintillatio, & Fluctuatio Caudarum unde ?], 508.
- The twinkling of the fixed stars: where does it come from? [Scintillatio Fixarum unde ?], 373.
- What is required for the twinkling of celestial bodies [Scintillationis corporum cœleſtium requiſita.], 432.
- The true cause of the twinkling of stars [Scintillationis Stellarum vera cauſa.], 373.
- Air that is sometimes more turbid, and a lower position of the comets, can bring about the twinkling and fluctuation of cometary tails [Scintillationem & Fluctuationem cometicarum caudarum aër nonnunquam fœculentior, decliviorq́; Cometarum ſitus inducere poſſunt.], 510.
- By what route is natural science attained? [Scientia naturalis quâ viâ obtineatur ?], 791.
- Let the investigator of nature always prefer reasons and observations to authority [Scrutator Naturæ, Rationes ſemper & Obſervationes præferat Auctoritati.], 423.
- The spoke on a drum: which one produces the greatest force [Scytala in tympano, quænam virtutem producit maximam.], 583.

- Visual sections: when do they recede more and more from the Earth? [Sectiones viſoriæ, quando magis magisq́; à terrâ elongantur ?], 640.
- What is a parabolic section? [Sectio parabolica quid ?], 660.
- Secondary comets: why do they mostly deceive people's eyes? [Secundarii Cometæ, cur hominum plerumq́ue fallant oculos ?], 429.
- Description of secondary comets [Secundariorum Cometarum Deſcriptio.], 428.
- The semidiameter of Saturn's sphere [Semidiameter Sphæræ Saturni.], 714.
- The Author's opinion on the new star in the neck of Cetus [Sententia Auctoris de ſidere novo in collo Ceti.], 378.
- Kepler's opinion on the matter of tails [Sententia de Materiâ Caudarum Kepleri.], 471.
- An opinion on the new and wonderful star in the neck of Cetus: which is most consonant with reason [Sententia de novâ & mirâ Stellâ in collo Ceti,quænam rationi ſit convenientisſima.], 379.
- Various opinions on the tails of comets [Sententiæ variæ de Cometarum Caudis.], 470,471,472.
- Various opinions of authors on the direction of comets [Sententiæ Auctor. variæ de Cometarum directione.], 462.
- Kepler's opinions on the tails of comets: the Author does not agree with them [Sententiæ Kepleri de Cometarum caudis, Auctor non adſtipulatur.], 481.
- The opinion of Seneca and of Rothmann on the tails, the matter and the generation of comets [Sententia Senecæ, & Rothmanni, de Cometarum caudis, Materiâ, & Generatione.], 469.
- Sense is the beginning of all thought [Senſus omnium cogitationum principium.], 354.
- In sensible things one must abide by the judgement of the senses, and philosophize by it [Senſuum judicio in rebus ſenſibilibus ſtandum, & philoſophandum.], 354.
- Haired stars move with rectilinear motion [Sidera crinita motu feruntur rectilineo.], 569.
- The emergence of the new star in Cassiopeia [Sideris novi in Casſiopeâ exortus.], 374.
    - the magnitude and brightness of the new star in Cassiopeia were not always the same [novi in Casſiopeâ Magnitudo ac Claritas, non perpetuò fuit eadem.], 374.
    - the wonderful changeability of the new star in the neck of Cetus [novi in collo Ceti mira vicisſitudo.], 376.
- Observers of the stars who have examined them with suitable instruments have been very few [Siderum Obſervatores, qui inſtrumentis idoneis ea rimati ſunt, paucisſimi extitére.], 429.

- The generation and corruption of new stars [Siderum novorum Generatio & Corruptio.], 421.
- The new star in the neck of Cetus: is it subject to any rectilinear motion? [Sidus novum in collo Ceti, num motui aliquo rectilineo ſit obnoxium ?], 379.
    - the new star in the neck of Cetus was by no means newly created by God [novum in collo Ceti, neutiquam à DEO recens eſt creatum.], 379.
- The position of a comet and the sections: when do they change? [Situs Cometæ & Sectiones, quando permutantur?], 640.
- The position of the path of comets: how is it determined? [Situs Cometarum Trajectoriæ, quomodo determinatur ?], 593,594.
- Snellius's observation of the comet of 1618 [Snellii Cometæ 1618 Obſervatio.], 881.
    - the opinion of Snellius and Crüger on the angle of inclination of the comet of the year 1618 [& Crügeri de inclinationis angulo Cometæ anni 1618 ſententia.], 117.
    - the opinion of Snellius and Kepler on the vibration of tails [& Kepleri de Vibratione caudarum opinio.], 511.
- The body of the Sun is subject to the greatest alterations of all the bodies of the world [Solare corpus, alterationibus obnoxium eſt inter mundana corpora, omnium maximis.], 359.
- The Sun's evaporations, as it were, glue together the exhalations of the other planets [Solares Evaporationes, Planetarum reliquorum exſpirationes quaſi conglutinant.], 385.
    - the Sun's evaporations tend strongly toward condensation [Evaporationes, ad condenſationem valdè propendent.], 385.
    - solar spots: some last longer than others [Maculæ, aliæ aliis ſunt diuturniores.], 409.
    - solar spots: do they grow and diminish? [Maculæ, an creſcant & decreſcant ?], 408.
    - solar spots sometimes perish within a short time [Maculæ brevi interdum intereunt.], 428.
    - solar spots do not rotate about an axis [Maculæ circa axem non rotantur.], 410.
    - solar spots grow more quickly than they dissolve [Maculæ citiùs creſcunt, quàmdisſolvuntur.], 424.
    - solar spots contribute much light to comets, above all with respect to their generation [Maculæ Cometis multùm conferunt luminis, inprimis ratione generationis.], 407.
    - solar spots are immense and wonderful bodies [Maculæ corpora ſunt immenſa, & admiranda.], 401.
    - solar spots have characteristics similar to those of comets [Maculæ cum Cometis ſimiles habent affectiones.], 433.

- Solar spots sometimes have a tail too [Solares Maculæ, & caudam nonnunquam habent.], 556.
    - solar spots arise from evaporations [Maculæ ex evaporationibus promanant.], 360.
    - solar spots, faculae and shadows are subject to continual changes [Maculæ, Faculæ atque Umbræ, continuis obnoxiæ ſunt mutationibus.], 508.
    - solar spots require an immense quantity of smoky evaporations [Maculæ immenſam fumidarum Evaporationum copiam requirunt.], 403.
- Some solar spots: how often they return [Solares Maculæ nonnullæ, quoties redeant.], 409.
    - solar spots have a zodiac of their own [Maculæ peculiarem habent Zodiacum.], 409.
    - solar spots: how many the Author detected in one year [Maculæ,quot uno anno ab Auctore deprehenſæ.], 404.
    - solar spots: how many, and of what kind, were noticed on the Sun's disc in one year [Maculæ, quot & quales uno anno in Solis diſco ſunt animadverſæ.], 404.
    - solar spots: how they are generated and dissolved [Maculæ,quomodo generentur & diſſolvantur.], 349.
    - solar spots are disc-shaped bodies [Maculæ ſunt Corpora diſcea.], 419.
    - solar spots enjoy a different motion in each month [Maculæ, ſingulis Menſibus diverſo gaudent motu.], 410.
- The Sun's rays are not stopped in the aether [Solares radii in æthere non ſiſtuntur.], 471, 475.
    - the Sun's rays are stopped only in a denser medium [radii non niſi in medio ſiſtuntur denſiori.], 477.
    - unless the Sun's rays pass through the head of the comet and that thinner matter adhering to the comet, the comet has no tail [radii, niſi per caput Cometæ, materiamq; illam Cometæ adhærentem tenuiorem transſcendant, cauda Cometæ datur nulla.], 481.
    - the Sun's rays are bent through the comet's head [radii, per Cometæ caput incurvantur.], 501.
    - the Sun's rays: by what means they are tinged with colours [radii, quâ ratione coloribus tingantur.], 515.
    - the Sun's rays: how they are refracted from the perpendicular [radii, quomodo à perpendiculo refringantur.], 502.
    - the Sun's rays: how they are seen [radii, quomodo conſpiciantur.], 481.
    - the more vivid and stronger the Sun's rays, and the more ample the accompanying matter, the greater and longer the tail [radii, quò

ſunt vividiores fortioresq́;, atq́ue materia concomitans amplior, eò cauda eſt major, atq́ue longior.], 544.

- Do solar meteors exist? [Solaria Meteora an dentur ?], 387.
- Scheiner's remarkable observation of a solar spot [Solaris Maculæ inſignis Obſervatio Scheineri.], 479.
  - a very rare example of a particular solar spot observed by the Author [alicujus Maculæ, ab Auctore obſervatæ, exemplum rariſſimum.], 424.
  - demonstration of the solar atmosphere [atmoſphæræ demonſtratio.], 361.
  - the rotation of the Sun's body produces the flow and ebb of that fiery sea [corporis circumrotatio, fluxum & refluxum efficit Pelagi illius ignei.], 360.
  - description of the Sun's body, according to the Author's view [Corporis Deſcriptio, ex mente Auctoris.], 359,360.
  - the shadow of a solar spot lying in the southern part of the Sun appears somewhat more depressed [Maculæ in parte Solis Auſtrali verſantis, Umbra conſpicitur aliquantò depreſſior.], 479.
  - the shadow of a solar spot lying in the northern part of the Sun stands somewhat higher [Maculæ, in parte Solis Septentrionali verſantis, Umbra exiſtit aliquantò elevatior.], 479.
- To know the quantity of the Sun's evaporations seems almost absurd [Solarium Evaporationum copiam cognoſcere, abſonum ferè videtur.], 404.
  - the apparent diameter of solar spots: how large it is at different distances from the Earth [Macularum apparens Diameter, quantaſit in diverſis à Terrâ diſtantiis.], 402.
  - the tails of solar spots: which way they point [Macularum Caudæ, quò vergant.], 556.
  - in respect of their properties there is a very great agreement between solar spots and comets [Macularum cum Cometis, ratione proprietatum, magna admodùm eſt convenientia.], 407,414.
  - the colour and density of solar spots [Macularum Color,& Denſitas.], 408.
  - the distance of solar spots: is it always the same from the Sun? [Macularum Diſtantia, an ſit à Sole ſemper eadem ?], 410.
  - the duration of solar spots and of their nuclei [Macularum & Nucleorum duratio.], 409.
  - the appearance and size of solar spots, if they are viewed at close range [Macularum facies, & magnitudo, cominùs ſi ſpectentur.], 402.
  - the size of solar spots and faculae [Macularum Facularumq́; magnitudo.], 401,410.
  - the form of solar spots [Macularum Forma.], 408.

    - the generation and corruption of solar spots [Macularum Generatio, & Corruptio.], 411.
    - the time at which solar spots are generated [Macularum generationis Tempus.], 408.
    - the perishing of solar spots [Macularum interitus.], 410.
- The origin of the light of solar spots [Solarium Macularum Luminis Origo.], 410.
    - the true size of the diameter of larger and smaller solar spots [Macularum majorum & minorum vera Diametri quantitas.], 403.
- The changes and alterations of solar spots arise within a very short space of time [Solarium Macularum Mutationes & Alterationes, brevisſimo oriuntur ſpatio.], 402.
    - the changes of solar spots are not rarely sudden [Macularum mutationes,non rarò ſunt ſubitaneæ], 424.
    - the motion of solar spots is unequal [Macularum Motus eſt inæqualis.], 410.
    - the nuclei of solar spots: do they always occupy the centre of the spots? [Macularum Nuclei, an Centrum in Maculis ſemper obtineant ?], 409.
    - the nuclei of solar spots grow and diminish [Macularum Nuclei, creſcunt & decreſcunt.], 409.
    - the nuclei of solar spots have their own atmospheres [Macularum Nuclei,ſuas habent atmoſphæras.], 409.
    - the nuclei of solar spots: where they arise from [Macularum Nuclei, unde exoriantur.], 409.
    - the physical and astronomical origin of solar spots [Macularum Ortus Phyſicus & Aſtronomicus.], 408.
    - the manner in which solar spots are produced [Macularum procreationis modus.], 408.
    - diagrams of solar spots [Macularum Schemata.], 411.
    - a concise description of solar spots [Macularum ſuccincta deſcriptio.], 407.
    - the reflection and refraction of the Sun's rays in the cometary head [Radiorum in Capite cometico reflexio; & refractio.], 502.
    - the progression of the Sun's rays [Radiorum progresſio.], 502.
- The Sun is, as it were, the centre of the comets [Sol centrum quaſi eſt Cometarum.], 701.
- The Sun can be obscured by a comet at a certain time [Sol certo tempore à Cometâ obſcurari poteſt.], 540.
- The Sun consists of solid and liquid parts [Sol conſtat ex partibus ſolidis & liquidis.], 359.
- Why does the Sun not twinkle? [Sol cur non ſcintillet ?], 432.
- The Sun appeared girdled with circles of different colours [Sol diſcoloribus circulis cinctus apparuit.], 800,802.

- A comet brighter than the Sun, its tail occupying a quarter of the sky [Sole clarior Cometa, caudâ quartam cœli partem occupans.], 449.
- While the Sun was in eclipse, a comet shone out [Sole deficiente, Cometa affulſit.], 801.
- Comets seen by day while the Sun was shining [Sole ſplendente, Cometæ interdiu viſi.], 541.
- The Sun does not eject an equal amount of matter from its body every year [Sol ex Corpore ſuo non æque multum materiæ ſingulis annis evomit.], 405.
- The Sun exhales an immense quantity of evaporations, so that innumerable comets could be produced from them [Sol immenſam evaporationum copiam exhalat, ut Cometæ ex iis procreari posſint innumeri.], 405.
- Three suns were seen at midday [Soles in meridie tres ſunt viſi.], 841.
- Solider bodies are more capable of motion [Solidiora corpora capaciora ſunt motûs.], 676.
- The Sun is fiery and extremely bright [Sol igneus eſt, & lucidisſimus.], 359.
    - in the deviation of comets the Sun does the same as the director does by means of the ropes in directing the sailing [in deviatione Cometarum idem præſtat, quod Director ope funiculorum in directione velificationis.], 682.
    - the Sun appeared like red-hot iron at Cæsareopolis [inſtar ferri candentis Cæſareopoli apparuit.], 361.
- When is the same face of the cometary body exposed to the Sun and to the Earth? [Soli, quando cometici corporis facies, & terræ exponitur eadem ?], 708.
- The distance of the Sun from the Earth according to various authors [Solis à Terrâ diſtantia ſecundùm varios Auctores.], 702.
    - the Sun's interval from the Earth [à Terra intervallum.], 397.
    - the apparent diameter of the Sun seen from the Earth and the planets [Diameter apparens exTerrâ Planetisq; ſpectata.], 398.
    - the diameter of the Sun seen from the fixed stars [Diameter ex Fixis ſpectata.], 391.
    - a remarkable eclipse of the Sun [Eclipſis inſignis.], 834.
    - an eclipse of the Sun that occurred in the time of the Emperor Honorius [Eclipſis tempore Honorii Imperatoris facta.], 809.
- The size of the Sun and of the Moon from Saturn and Jupiter [Solis & Lunæ ex Saturno & Jove Magnitudo.], 399.
- The size of the Sun and of the Earth [Solis & Terræ Magnitudo.], 338.
    - the incredible exhalation of the Sun [Exſpiratio incredibilis.], 403.
- In the orb of the Sun the first dissolution of comets usually takes place [Solis in Orbe diſſolutio plerumq; Cometarum prima contingit.], 386.
- In the orb of the Sun the chief cometary matter is found [Solis in Orbe, præcipua datur Materia Cometica.], 386.

    - the place of the Sun was computed from the Danzig Tables for the comet of 1652 [Locus ex Tabulis Dantiſcanis, pro Cometâ 1652 ſupputatus eſt.], 18.
    - the proportion of the Sun and of the Moon to the Earth [Lunæq; ad Terram proportio.], 335.
- The Sun's spots: how many were seen in the year 1625 [Solis Maculæ, quot anno 1625 conſpectæ.], 405.
- The liquid matter of the Sun is true fire [Solis materia liquida verus eſt ignis.], 359.
- Why the light of the Sun sometimes appears paler and weaker [Solis lumen unde nonnunquam pallidius debiliusq; appareat.], 361,362.
- The Sun communicates light to comets [Sol lumen Cometis communicat.], 435.
- The Sun is never free of every spot [Sol nunquam liber eſt ab omni Maculâ.], 410.
    - the Sun: in how many days does it complete the period of its rotation? [periodum ſuæ vertiginis,quot diebus abſolvat ?], 695.
    - the Sun is the centre of the planets [Planetarum eſt Centrum.], 385.
    - when does the Sun suffer an eclipse from a comet? [quando ex Cometâ deliquium patitur ?], 710.
    - the Sun sometimes appears as if wholly stripped of its rays, so that stars can be seen at midday itself [quandoque radiis prorsùs nudatus quaſi apparet, ut in ipſo meridieStellæ conſpici poſſint.], 361.
    - by how much is the Sun greater than the Earth? [quantò Terra exiſtat major ?], 338.
    - how much evaporation the Sun throws out every year [quantum Evaporationum quotannis ejiciat.], 403.
    - how the Sun can carry comets round with its annual motion while leaving their own proper motion unimpaired is quite difficult to grasp [quomodo Cometas motu ſuo annuo circumducere poſſit, illæſo motu ejus proprio, captu prorsùs eſt difficile.], 589 & 590.
- The Sun too has its own equator and poles [Sol quoque ſuum poſſidet Æquatorem, Poloſq;.], 753.
    - how many miles does the Sun cover by the motion of the first mobile in the space of one second? [quot milliaria motu primi mobilis unius ſcrupuli ſecundi ſpatio conficit ?], 706.
    - how many phenomena of the Moon and the Earth, equal as regards the disc, the Sun can produce in one year [quot phænomena Lunæ Terræq; æqualia quoad diſcum uno anno producere poſſit.], 404.
    - the Sun showed a blood-red colour [ſanguineum repræſentavit colorem.], 825.
    - the Sun has its own atmosphere, in which alterations occur even more frequently than in ours [ſuam habet atmoſphæram, in quâ alterationes etiam noſtris frequentiores accidunt.], 365.

- Very many comets can be produced by the Sun in one year [Sol uno anno plurimos procreari poteſt Cometas.], 401.
- Sound: in what space of time it is heard [Sonus, quanto temporis ſpatio, exaudiatur.], 702.
- Speculations on the spiral motion of comets are useful [Speculationes de motu Comet.ſpirali proſunt.], 671,672.
- Speculative matters cannot always rightly be carried into practice [Speculati[[v/y]]a, non ſemper ad praxin deduci rectè posſunt.], 165.
- The extent of the sphere of the fixed stars [Sphæræ Fixarum amplitudo.], 714.
- Why spherical bodies, once set going in a circle, pursue a circular motion unceasingly and cannot take up another [Sphærica corpora in orbem ſemel acta, motum circularem, cur indeſinenter proſequantur, nec alium asſumere posſint.], 569.
- Stationary phenomena: how they come about [Stationaria, undefiunt phænomena.], 638.
- Stationary: when the comet of 1607 was so [Sationarius, quando Cometa 1607 fuerit.] [recte: Stationarius], 623.
- How comets enter on a station [Stationem quomodo Cometæ ineunt.], 618.
- The stations and retrogressions of comets cannot be explained by tangents if the Earth is at rest [Stationes & retrogresſiones Cometarum, Terrâ ſtabili, per Tangentes explicari haud posſunt.], 778.
- The adventitious star in the foot of Cygnus: when it began to decrease in magnitude [Stella adſcititia in pede Cygni,quando magnitudine decreſcere inceperit.], 375.
    - a star with curled hair, otherwise called Hircus [circinnata, aliàs Hircus dicta.], 442.
    - a star observed like a column [columnæ inſtar deprehenſa.], 808.
    - a maned star seen at the time of a solar eclipse [comata,tempore Eclipſeos Solaris conſpecta.], 450.
    - a haired star like a burning column [crinita,ardenti columnæ ſimilis.], 807.
    - a haired star stretching its larger hair towards the east and its smaller towards the south [crinita, crines majores ad Orientem,minores Auſtrum versùs protendens.], 820.
    - a haired star of immense size [crinita immenſæ magnitudinis.], 806.
    - a huge haired star, at one moment carrying fire before it, at another leaving smoke behind it [crinita ingens, modò ignem præ ſe ferens, modò fumum poſt ſe relinquens.], 825.
    - a haired star shining near the Morning Star and yielding very little to it [crinita propè Luciferum refulgens, eiq́; non admodùm cedens.], 807.

- Haired stars, even if they are carried under a great circle, can nevertheless move under different lines [Stellæ crinitæ,etiamſi ſub Circulo ferantur maximo, posſunt tamen ſub diverſis moveri lineis.], 559.
    - two stars seen of a fiery colour [duæ, ignei coloris viſæ.], 823.
    - the fixed stars all twinkle [fixæ corruſcant omnes.], 432.
    - if all the fixed stars were rightly observed, it would greatly benefit astronomy [fixæ omnes, ſi rectè obſervarentur, rei Aſtronomicæ valdè conduceret.], 400.
    - the fixed stars: by what means they are produced [fixæ, quâ ratione producantur.], 422.
- The fixed stars: if they moved in orbs, could they produce a parallax? [Stellæ fixæ, ſi moverentur in orbibus, an parallaxin producere posſent ?], 423.
    - some stars were once brighter [nonnullæ lucidiores olim extiterunt.], 374.
    - new stars surpass comets in brightness [novæ claritate Cometas ſuperant.], 391.
    - new stars change their colour and light in various ways [novæ Colorem & Lumen diverſimodè mutant.], 374.
    - new stars grow and diminish [novæ creſcunt ac decreſcunt.], 374.
    - new stars: why do they have no tails? [novæ, cur nullas habeant caudas ?], 556.
    - the magnitude of the new star that arose in Cassiopeia in the year 1572 [novæ in Casſiopeâ an. 1572 exortæ Magnitudo.], 394.
    - the increase and decrease of the new star in the foot of Serpentarius [novæ in pede Serpentarii auctio & diminutio.], 375.
    - new stars sometimes arise in the aether and pass away again [novæ nonnunquam in æthere oriuntur, rurſusq; occidunt.], 374.
    - new stars always twinkle [novæ ſcintillant ſemper.], 433.
- Stars sometimes shine out brightly at the time of a solar eclipse [Stellæ, tempore Eclipſeos Solaris, nonnunquam clarè affulgent.], 363.
- A star like the Morning Star [Stella inſtar Luciferi.], 825.
    - the new star in the neck of Cetus changed its colour somewhat [nova in collo Ceti, colorem nonnihil mutavit.], 378.
    - the new star in the neck of Cetus grows and diminishes [nova in collo Ceti creſcit & decreſcit.], 377.
    - the new star in the neck of Cetus is located in the highest aether [nova in collo Ceti in altisſimo verſatur æthere.], 378.
    - the new star in the neck of Cetus always shines in the same place in the sky [nova in in collo Ceti ineodem ſemper cœli loco affulget.], 378, 380.
    - the new star in the neck of Cetus undergoes wonderful changes [nova in collo Ceti miras ſubit vicisſitudines.], 378.

    - the new star in the neck of Cetus sometimes vanishes [nova in collo Ceti nonnunquam evaneſcit.], 377.
    - the new star in the neck of Cetus: can it be reduced to nothing in the space of a few months and coagulate again? [nova in collo Ceti, num in nihilum aliquot Menſium ſpatio redigi, ac rurſus coagulari posſit?], 379.
    - the new star in the neck of Cetus: is it subject to any rectilinear motion? [nova in collo Ceti, num motui aliquo rectilineo ſit obnoxia ?], 379.
- The new star in the neck of Cetus: by what means it grows and diminishes [Stellanova in collo Ceti, quâ ratione creſcat ac decreſcat.], 380.
- The new star in the neck of Cetus: by what means it so often rises and sets [Stella nova in collo Ceti, quâratione toties oriatur, & occidat.], 380.
- The new star in the neck of Cetus: how it takes on a different magnitude and colour [Stella nova in collo Ceti, quo pacto diverſam induat magnitudinem, & colorem.], 380.
    - the new star in the neck of Cetus by no means returns at a fixed time [nova in collo Ceti, ſtato tempore minimè redit.], 380.
    - the new star in Cygnus: how long it lasted in the sky [nova in Cygno, quamdiu in cœlo duraverit.], 381.
    - a new star has no hair [nova nullam habet comam.], 391.
- The Pole Star once vanished [StellaPolaris aliquando evanuit.], 374.
- The definite and exact number of the fixed stars has not yet been determined [Stellarum fixarum certus & accuratus numerus, nondum eſt determinatus.], 400.
    - the magnitude of the fixed stars as seen from Saturn [fixarum Magnitudo, ex Saturno ſpectata.], 399.
    - the birth of the fixed stars is much more difficult than that of comets [fixarum Nativitas, multò eſt difficilior,quàm Cometarum.], 422.
    - very many of the fixed stars were not observed by the ancients [fixarum plurimæ,àVeterib9 non ſuntobſervatæ.], 400.
    - the twinkling and flashing of the fixed stars: where they come from [fixarum Scintillatio, & Corruſcatio unde.], 373.
    - a description of new stars [novarum Deſcriptio.], 390.
    - the manner of birth of new stars and of comets is not one and the same [novarum & Cometarum naſcendi ratio, non eſt una eademq́;.], 422,423.
    - the manner of generating and producing new stars is not always the same [novarum generandi & producendi ratio, non eſt ſemper eadem.], 390, 391.
    - the time of birth of new stars [novarum naſcendi tempus.], 426.
    - the origin of new stars: why does it occur more often in the Milky Way? [novarum Ortus, cur ſæpius fiat in viâ lacteâ ?], 424.

- The manner in which new stars arise and pass away [Stellarum novarum oriendi & occidendi ratio.], 391.
- That some fixed stars have changed as regards their magnitude is proved by observations [Stellas fixas nonnullas, quà Magnitudinem esſe immutatas, Obſervationibus probatur.], 400.
- That new stars can fairly often arise from the exhalations of the fixed stars and pass away again is not wholly at odds with reason [Stellas novas ex Fixarum exhalationibus oriri ſæpiusculè, & rurſus occidere posſe, rationinon planè eſt abſonum.], 399, 406.
- Even of sublunary things the causes and effects are unknown [Sublunarium etiam rerum cauſæ & effectus ignorantur.], 393.
- The leapings, flickerings and fluctuations of tails are not always the same [Subſultationes, Micationes, & Fluctuationes caudarum, non ſemper ſunteædem.], 512.
- The subtenses of the motion of the Earth: by what means they are computed [Subtenſæ motûs terræ,quâ ratione ſupputantur.], 595.
- A bright and conspicuous haired star [Sydus crinitum clarum atque conſpicuum.], 802.
    - a haired star with a double tail [crinitum duplici caudâ.], 820.
    - a haired star seen by day [crinitum interdiu viſum.], 806.
    - a haired star with a very long tail, seen by night and by day [crinitum longisſimâ caudâ,noctu interdiuq; conſpectum.], 816.
    - a pale star with a short tail [pallidum caudâ brevi.], 849.
- Why is the train of comets usually broader in the middle? [Syrma Cometarum in medio, cur plerumque ſit amplius?], 536.

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- A table giving the angle of inclination to the ecliptic and the node of the comet of 1577 [Tabella, Angulum inclinationis ad Eclipticam, Nodumq; Cometæ 1577, referens.], 115.
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    - a table showing the greatest apparent lengths of various cometary tails at various intervals, and the distances of the comet from the Sun [apparentes longitudines maximas, diverſarum Caudarum cometicarum ad diverſa intervalla, & Cometæ à Sole diſtantias, exhibens.], 530.
    - a table of the apparent diameter of the Earth, as if seen from the planets at their mean distance from it [apparentis Diametri terræ, ex Planetis mediocriter ab ipsâ diſtantibus quaſi ſpectatæ.], 398.
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    - a table showing the intervals of the comet of 1665 from the Sun, the angle of the Sun's ray with the path, etc. [Cometæ 1665 à Sole intervalla, angulum radii Solis cum Traject. &c. exhibens.], 772.
    - a table giving the calculation of the comet of 1531 [Cometæ 1531 Calculum referens.], 614.
- A table giving the interval of the comet of 1664 from the Sun, the angle of the Sun's ray with the path, etc. [Tabella Cometæ 1664 intervallum à Sole, angulum radii Solis cum Trajectoriâ, &c. referens.], 766.
    - a table showing the interval of the comet of 1665 with the corresponding horizontal parallaxes [Cometæ 1665 intervallum cum competentibus parallaxibus horizontalibus exhibens.], 771.
    - a table presenting the distances of the more notable comets from the Earth, and their duration, etc. [Cometarum inſigniorum à terrâ Diſtantias, & Durationem &c. repræſentans.], 322.
    - a table showing the distances of the perpendiculars of the comet of 1664 on its trace from the centre of the Earth [Diſtantias Cometæ 1664 perpendiculorum in veſtigio ex centro terræ exhibens.], 762.
- A table setting out the distances of the companions from Saturn and Jupiter, together with their diameters as they appear from Jupiter and Saturn [Tabella Diſtantias Comitum à Saturno & Jove, unà cum Diametris illorum ex Jove & Saturno apparentibus proponens.], 397.
    - a table showing the difference in the proper motion of some comets at their greatest velocity [diverſitatem motûs proprii Cometarum nonnullorum, in ſummâ eorum velocitate exhibens.], 690.
    - a table giving the interval of the comet of 1661 from the Sun, the angle of the Sun's ray with the path, etc. [intervallum Cometæ 1661 à Sole, Angulum radii Solis cum Traject. &c. referens.], 752.
    - a table giving the size of Saturn and of its laterones, or arms [Magnitudinem Saturni & Lateronum,ſeu brachiorum ejus referens.], 397.
- A table showing the apparent motion of some imaginary comet ascending in a straight line from the Sun [Tabella motum Cometæ alicujus ficti apparentem, rectâ à Sole aſcendentis exhibens.], 637.
    - a table showing the apparent and the true motion of the comet of 1472 in its orbit [Motum Cometæ 1472 apparentem atque verum in ſuâ Orbitâ exhibens.], 604.
    - a table showing the daily motion of the comet of 1661 [Motum Cometæ 1661 diurnum exhibens.], 751.
    - a table showing the daily motion of the comet of 1665 [Motum Cometæ 1665 diurnum exhibens.], 772.
    - a table containing the extent of the travelled path of certain comets [quorundam Cometarum magnitudinem viæ itiitinerariæ continens.] [recte: itinerariæ], 715.

    - a table showing various angles together with the subtenses of the motions of the Earth, for the comet of 1652 [varios angulos unà cum ſubtenſis motuum terræ, pro Cometâ 1652 exhibens.], 598.
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    - a table showing the velocity of the proper motion of the planets around the Sun, according to the Author's hypotheses [velocitatem motûs proprii Planetarum circa Solem, juxta Auct. hypotheſ. exhibens.], 703.
- A table showing the continuous daily motion of the comet of 1652 [Tabula motum diurnum, Cometæ 1652 continuum exhibens.], 119.
    - a table showing the angle of inclination and the node of the comet of 1577 [Angulum Inclinationis, Nodumq́; Cometæ 1577 exhibens.], 113.
    - a table showing the angle of the orbit of the comet of 1652 for each day and their quarters [Angulum Orbitæ Cometæ 1652 ad ſingulos dies eorumq́; quadrantes exhibens.], 128.
    - a table giving the apparent diameter of the Earth as seen from the planets [apparentem terræ Diametrum, ex Planetis conſpectam referens.], 370.
    - a table showing the summary of the calculation of the comet of 1472 [Calculi Cometæ 1472 ſummam exhibens.], 602.
    - a table presenting the true length of the cometary tail of 1652 [Caudæ cometicæ 1652 Longitudinem veram repræſentans.], 533.
    - a table setting out the distance of the comet of 1652 from the Earth and its observed apparent diameter [Cometæ 1652à terrâ Diſtantiam, & obſervatam Diametrum apparentem proponens.], 347.
    - a table showing the chief heads of the calculation of the comet of 1652 [Cometæ 1652 Calculi capita exhibens.], 630,631.
    - a table showing the apparent length of the tail of the comet of 1652, the true length of the tail being taken on each day as 28 semidiameters of the Earth [Cometæ 1652 caudæ longitudinem apparentem exhibens,datâ ſcilicet ſingulis diebus verâ longitudine caudæ 28 Sem. Terræ.], 543.
- A table showing in numbers the size of the apparent diameter of the comet of 1652 [Tabula Cometæ 1652 Diametri apparentis Magnitudinem in numeris exhibens.], 327.
    - a table giving the size of the diameter and of the body of the comet of 1652, which it had on each day at its varying distance from the Earth [Cometæ 1652 Diametri Corporisq́; Magnitudinem, quam ſingulis diebus in diversâ à Terrâ diſtantiâ obtinuit, referens.], 337.

- a table showing the place of the comet of 1652 with respect both to the ecliptic and the equator and to the Sun [Cometæ 1652 Locum tàm reſpectu Eclipticæ, & Æquatoris, quàm Solis exhibens.], 86.
- a table showing the proportion of the size of the comet of 1652 according to Kepler's hypotheses [Cometæ 1652Magnitudinis proportionem exhibens, ſecundùm hypotheſes Kepplerianas.], 337.
- a table showing the vertical and horizontal parallaxes of the comet of 1652, from the apparent and true altitudes [Cometæ 1652 parallaxes verticales, & horizontales exhibens,ex viſis & veris Altitudinibus.], 292.
- a table containing the chief heads of the calculation of the comet of 1661 [Cometæ 1661 Calculi capita continens.], 749.
- a table of the parallax and of the distance from the Earth of the comet of 1661 [Cometæ 1661 parallaxeos & diſtantiæ à Terrâ.], 745.
- a table showing, for the comets of 1661, 1664 and 1665, the variation of the angle of inclination, the node, the longitude, the latitude and the motion in the circle of their course [Cometarum 1661,1664 & 1665 anguli inclinationis variationem, Nodum, Longit. Latit. Motumq́; in circulo itinerisexhibens.], 776.
- a table showing the chief heads of the calculation of the comet of 1664 for an entirely straight path [Cometæ 1664 Calculi capita ad Trajectoriam omninò rectam exhibens.], 763.

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  - a table showing the chief heads of the calculation of the comet of 1665 [Cometæ 1665 Calculi capita exhibens.], 769.
- A table showing the parallaxes of the comet of 1664 and its intervals from the Earth [Tabula, Cometæ 1664 parallaxes, ejusq́; à Terrâ intervalla exhibens.], 757.
- A table giving the deflections of the tails of the comets of 1661, 1664 and 1665, the distance of the head from the Sun, etc. [Tabula, Cometarum 1661, 1664 & 1665 Caudarum deflexiones, diſtantiam capitis à Sole,&c. referens.], 775.
  - a table presenting the sizes of the companions of Saturn and Jupiter [Comitum Saturni & Jovis Magnitudines repræſentans.], 397.
  - a table by means of which one learns whether the prosthaphaeresis is to be added or rather subtracted [cujus beneficio cognoſcitur, an Proſthaphæreſis ſit addenda, an verò ſubtrahenda ?], 196.
- A table containing the declinations, right ascensions, longitudes and latitudes of certain fixed stars, for the comet of 1652 [Tabula Declinationes,Aſcenſ.R.Longit.&Latit.Fixarum quarund. pro Cometâ 1652 continens.], 19.

- A table showing the deviations of certain comets [Tabula, Deviationes quorundam Cometarum exhibens.], 487.
    - a table showing the proportion of the diameters and solid volumes of the Sun, the Moon, the comet and the Earth [Diametrorum & Soliditatum Solis, Lunæ, Cometæ & Terræ proportionem exhibens.], 336.
- A table showing how large the tail of the comet of 1652 would have appeared on each day if it had always remained of the same size [Tabula exhibens, quanta ſingulis diebus apparuiſſet cauda Cometæ 1652, ſi perpetuò manſiſſet ejusdem quantitatis.], 543.
- A table giving the angle of inclination to the ecliptic and the node of the comet of 1618 [Tabula, Inclinationis angulum ad Eclipticam, Nodumq́; Cometæ 1618 referens.], 119.
    - a table giving the proper motion of the comet of 1652, spread out over the single days and hours of its whole duration [Motum Cometæ 1652 proprium,ad ſingulos dies & horas totius durationis expanſum referens.], 110.
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    - a table giving the motion of certain comets in their path, and the angle of the Sun's ray and the path [Motum quorundam Cometarum in Trajectoriâ, Angulumq́; radii Solis & Traject. referens.], 691.
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- A table showing the true longitudes and right ascensions of the Sun for the comet of 1652 [Tabula veras Longitudines, & Aſcenſ. Rect. Solis pro Cometâ 1652exhibens.], 19, 20, 21.
- Darts and arrows gradually deviate from a straight course [Tela & Sagittæ ſenſim à recto tramite declinant.], 586.
- With the telescope, comets are correctly recognised [Teleſcopio Cometæ rectè cognoſcuntur.], 473.

- With the telescope: what was first detected in the cometary body of 1661 [Teleſcopio in Corpore cometico 1661,quænam initiò ſunt detecta.], 894.
- With the telescope: who among observers first discovered a comet [Teleſcopio quis primùm inter Obſervatores Cometam detexerit.], 340.
- Hardly any telescope is to be hoped for from human ingenuity by which every smallest thing standing out on the celestial globes could be detected [Teleſcopium ab humanâ induſtriâ vix ullum eſt ſperandum, quo quævis minima in globis cœleſtibus extantia, deprehendi posſint.], 356, 357.
- Tillers, although they look very short, are nonetheless much longer than one supposes [Temones etſi videantur perbreves, opinione tamen multò ſunt longiores.], 582.
- The power of the tiller: when it is greatest, and when nil [Temonis potentia, quando eſt maxima, & nulla.], 583.
- The tiller: in what direction it can exert its greatest power [Temo, quâ directione maximam exercere posſit potentiam.], 581.
- The tiller: how it can readily steer the largest ships [Temo quâ ratione maxima navigia dirigere promptè queat.], 581.
- What is a tiller? [Temo quid ?], 578.
- Unusual storms and floods sometimes arise on the Sun [Tempeſtates & inundationes in Sole nonnunquam inſolitæ oriuntur.], 362.
- The method of finding the time from azimuths [Tempus eruendi ratio ex azimuthis.], 23.
- Time uncovers everything and brings it into the light [Tempus omnia detegit, & in Lucem exponit.], 771.
- The method of finding the true time [Tempus verum inveſtigandi ratio.], 21, 22, 23, 24.
- Dreadful darkness can be brought on by a comet, even for several days [Tenebræ ex Cometâ per aliquot etiam dies induci posſunt horrendæ.], 540.
- The Earth turns about its axis [Terra circa axem volvitur.], 665.
- The proportion of the Earth to the Sun and the Moon [Terræ ad Solem Lunamq́; proportio.], 335.
- The apparent diameter of the Earth, as seen from the planets [TerræDiamet.apparens exPlanetis conſpecta.], 370,398.
- The matter of the Earth and of the heavens is one and the same [Terræ & Cœli Materia una eſt eademq́;.], 355.
- Given the motion of the Earth, no straight motion exists on it [Terræ Motu dato, nullus datur in eâ motus rectus.], 664.
    - given the motion of the Earth, in what place a straight motion exists [Motu dato, quo in loco motus datur rectus.], 665.
    - the motion of the Earth must be assumed in dealing with the paths of comets [Motum circa trajectiones Cometarum ſupponere oportet.], 589.

    - the Reverend Father Pardies attacks the motion of the Earth [Motum impugnat R. P. Pardies.], 779.
    - all comets establish the motion of the Earth [Motum omnes Cometæ ſtabiliunt.], 780, 589.
    - the daily motion of the Earth: why is it not equal in every place on Earth? [Motus diurnus, cur non omni terrarum loco eſt æqualis ?], 665.
    - the motion of the Earth: where it almost vanishes and, conversely, where it is fastest [Motus ubi penè evaneſcit, & vicisſim ubi eſt velocisſimus.], 665.
- When the Earth and a comet advance toward the same region at the same time, the motion of the comet appears to be slowed [Terrâ & Cometâ eandem ſimul plagam incedentibus, motus Cometæ retardari videtur.], 635.
- Earth and heaven, just as they come from one and the same principle, so also consist of the same elements [Terra & Cœlum, prout ex uno eodemq; principio, ſic ex iisdem etiam conſtant Elementis.], 355.
    - the Earth is subject to almost innumerable generations [innumeris penè generationibus eſt obnoxia.], 356.
    - the Earth, although it has continually given off immense vapours, has nonetheless suffered no harm from them [licet immenſos vapores continuò emiſerit,noxam tamen nullam exinde contraxit.], 394.
- If the Earth were bored through to the centre, how stones would fall [Terrâ perforatâ usque ad centrum, quâ ratione lapides deciderent.], 665.
    - if the Earth is assumed immobile, comets can in no way be saved by eccentrics [ſuppoſitâ immobili, Cometæ per Eccentricos nullâ ratione ſalvantur.], 634.
    - when the Earth crosses the trace, both the position of the comet and that of the sections change [veſtigium transgrediente, & ſitus Cometæ,& Sectionum permutantur.], 640.
    - when the Earth passes beyond the trace, remarkable phenomena are observed [Veſtigium tranſcendente, mira deprehenduntur phænomena.], 635.
- The terrestrial spots: whether they can be made out from the superior planets [Terreſtres Maculæ, an ex Planetis ſuperioribus deprehendantur ?], 369.
    - terrestrial spots quite often travel across the disc of the Earth [Maculæ, diſcum terræ ſæpiùs peragrant.], 368.
    - terrestrial spots: in which part of the Earth they are more frequent [Maculæ, quâ in terræ parte ſunt frequentiores.], 369.
- The terrestrial spots: with what colour they appear as seen from the Sun [Terreſtres Maculæ, quo colore ex Sole appareant.], 369.
    - terrestrial spots also have their own changes [Maculæ, ſuas etiam habent vicisſitudines.], 369.

- Terrestrial things deviate somewhat from straight motion [Terreſtria, nonnihil à motu recto deviant.], 587.
- Theorems or axioms on the motion of comets [Theoremata ſeu Axiomata de Cometarum motu.], 644.
- Theorems on the encounter of cometary bodies [Theoremata de Corporum cometicorum occurſu.], 650.
    - theorems on the motion and trajection of comets [de motu & Trajectione Cometarum.], 638.
    - Kepler's theorems on the motion and trajection of comets are not universal [Keppleri de motu & Trajectione Cometarum non ſunt univerſalia.], 641.
- The Author's theory makes the motion of comets much quicker [Theoria Auctoris, Cometarum motum multò reddit concitatiorem.], 702.
- The Author's theory of the comet of 1661 agrees very closely with the heavens [Theoria Auctoris Cometæ 1661, cum cœlo perquàm convenit.], 749.
- The Author's theory agrees excellently with the observations and phenomena of the comet of 1577 [Theoria Auctoris cum Obſervationibus & Phænomenis Cometæ 1577, optimè convenit.], 618.
- The Author's theory is not so very absurd [Theoria Auctoris non usque adeò eſt abſurda.], 713.
- The theory of some imagined comet, visible for a whole year, which appears to cross the entire zodiac with a spiral motion [Theoria Cometæ alicujus ficti, atque integro anno conſpicui, qui totum Signiferum motu ſpirali trajicere apparet.], 636.
- The theory of the comet of 1472 [Theoria Cometæ 1472.], 604.
    - the theory of Apian's comet of 1531 [Cometæ 1531 Appiani.], 614.
    - the theory of the comet of 1577 [Cometæ 1577.], 616.
    - the theory of the comets of 1585 and 1590 [Cometæ 1585 & 1590.], 620.
    - the theory of the comet of 1618 [Cometæ 1618.], 627.
    - the theory of the comet of 1652 [Cometæ 1652.], 594.
- The theory of the comet of 1664 corresponds most exactly with the genuine observations and with the calculation [Theoria Cometæ 1664, cum genuinis Obſervationibus,atq; Calculo exactisſimè reſpondet.], 659,760.
- The theory of the Copernicans is certainly far more probable than that of the Ptolemaics [Theoria Copernicæorum, longè profectò eſt veroſimilior, quàm Ptolemaicorum.], 707.
- The theory from tangents errs enormously, now in excess, now in defect [Theoria ex tangentibus modò in exceſſu, modò in defectu enormiter peccat.], 786.
- By what means the theory from tangents can be helped [Theoriæ ex tãgentib.quâ ratione ſu[[b/h]]veniri poſſit?], 787.

- Why the theory from tangents sometimes departs so evidently from the heavens themselves [Theoria ex tangentibus, quare adeò evidenter nonnunquam ab ipſo cœlo deflectat ?], 777.
- A comet in the shape of a beam [Trabis figurâ Cometa], 449.
- The nearer the trajection of a comet comes to the Sun, the greater the variation in the angle of inclination of the disc [Trajectio Cometæ,quò Soli fit propiùs, eò major eſt anguli inclinationis diſci variatio.], 705.
    - the trajection of comets, falling along the course of the solar equator, indicates comets faster than the rest [Cometar. ad ductum Æquatoris Solaris incidens, velociores præ reliquis indicat Cometas.], 753.
    - the trajection of comets: whether it takes place along the section of a parabola, or rather along that of a hyperbola [Cometarum, an fiat juxta parabolæ, an verò hyperbolæ ſectionem.], 683.
    - the straight trajection of comets: by what route it is more easily worked out [Cometarum recta, quâ viâ faciliùs expediatur.], 776.
- Trajection through the aether and the air is easier than through water [Trajectio per ætherem aëremq́; facilior eſt, quàm per aquam.], 584.
- Toward which region the trajection takes place: how it is recognised from the sections of the lines of sight [Trajectio quam plagam versùs fiat, quomodo ex ſectionibus cognoſcitur viſoriarum.], 639.
    - the trajection: in which direction it is curved [quorſum incurvetur.], 658,750.
    - the trajection of the solar rays produces the comet's tail [Radiorum Solarium, Caudam Cometæ efficit.], 473.
- Where the trajection is fastest, and where it varies most [Trajectio ubi eſt celerrima,& ubi maximè variat.], 640.
- The path of the comets of 1577, 1585 and 1590 was in part oblique toward the Sun [Trajectoria Cometæ 1577, 1585 & 1590 ex parte fuit obliqua Solem versùs.], 619,620,622.
- The path of the comets of 1661, 1664 and 1665 was likewise oblique [Trajectoria Comet. 1661, 1664 & 1665 fuit itidem obliqua.], 747,764,770.
- Given a curved path of comets, the motion cannot be derived by tangents [Trajectoriâ Cometarum datâ incurvatâ, motus per tangentes derivari haud poteſt.], 747.
- The path of comets always shows a curved or conic course [Trajectoria Cometarum ductum ſemper refert incurvatum ſeu conicum.], 613,658,777.
- The path of comets is no tangent [Trajectoria Cometarum nulla eſt tangens.], 777.
    - the path of the comet of 1664: at what distance it stood from the great orb at its least remoteness [Cometæ 1664, quanto intervallo ab orbe magno in minimâ diſtitit remotione ?], 760.
    - the path of certain comets: how great its length was [Cometar.quorund.,quantæ fuerit Longitudinis.], 715.

    - the path of comets: in what place of the heavens it is to be placed [Cometarum, quo cœli loco ponatur.], 629.
    - the path of comets: to what kind of curved lines it belongs [cujus linearum curvatarum ſit generis ?], 659.
- By means of the path even the most wonderful comets of all are explained and demonstrated [Trajectoriæ beneficio, etiam omnium mirificentisſimi Cometæ explicantur, & evincuntur.], 632.
- Where the greatest curvature of the path occurs [Trajectoriæ curvitas maxima, ubi exiſtat.], 680,770.
- The lines of sight and the latitudes clearly indicate the course of the path [Trajectoriæ ductum manifeſtè lineæ indicant viſoriæ, & latitudines.], 594.
    - the curving of the path: why it is not the same in all comets [incurvatio,cur in omnib.Cometis non ſit eadem?], 770.
    - the curving of the path is recognised from the angle of obliquity [incurvatio,ex angulo cognoſcitur obliquitatis.], 750.
    - the curving of the path: in which comets it mostly occurs [incurvatio,in quibus Cometis plerumq́; accidit?], 770.
    - the curving of the path is now sharper, now blunter, according to the comet's distance from the Sun and from the perpendicular [incurvatio, pro Cometæ,à Sole & perpendiculo, intervallo,nunc acuminatior,nũc obtuſior eſt.], 684.
- Paths: to what extent they are curved [Trajectoriæ, in quantum incurventur ?], 684.
- The place, course and distance of the path are at once evident from the Author's hypothesis [Trajectoriæ locus, ductus atq́ue intervallum, ex Auctoris hypotheſi illicò patet.], 778.
- How the situation of the path of comets is determined [Trajectoriæ ſitus Cometar.quomodo determinatur?], 593.
- The path is straighter outside the annual orbit than inside it [Trajectoria extra orbem annuum, quàm intra eum eſt rectior.], 760 & 761.
    - the path ran outside the annual orbit, and above the sections, of the comet of 1664 [extra Orbem annuum, & ſupra ſectiones Cometæ 1664 incesſit.], 759.
    - the path is oblique in all comets [in omnibus Cometis obliquatur.], 750.
    - the path: in which comets it represents a hyperbola, and in which a parabola [in quibus Cometis hyperbolam, in quibus verò parabolam referat.], 684.
    - the path cannot be described in every place of the heavens [non omni cœli loco deſcribi poteſt.], 629.
    - the path mostly intersects the plane of the ecliptic [planum eclipticæ plerumq́ue interſecat.], 594.

    - the path: when it is blunter in the middle [quando in medio eſt ob[[t/r]]uſior.], 685.
    - the path: when and where it bends most [quando & ubi ſeſe maximè inflectit.], 770.
    - the path: when it is more curved in the middle [quando in medio eſt curvior.], 685.
    - the nearer the path is to the Sun, the more curved it is [quò Soli eſt propior, eò eſt curvior.], 761.
- The path mostly intersects the trace at a certain angle [Trajectoria, ſub certo angulo veſtigium plerumq́ue interſecat.], 592.
- It is proved that the path of comets does not recede uniformly from the Earth [Trajectoriam Cometarum non æqualiter à Terrâ removeri, probatur.], 321.
- To draw the path of any comet correctly is an arduous business [Trajectoriam cujuscunq́ue Cometæ rectè delineare, arduum negotium eſt.], 591.
    - to find the line of the path in the aether itself is not so easy [lineam in ipſo æthere invenire, haud adeò proclive eſt.], 591.
    - it is shown from all properly observed comets that the path is nearly straight [propemodùm dari rectam,ex omnibus ritè obſervatis Cometis commonſtratur.], 601.
    - how it is established that the path was correctly drawn in the comet of 1652 [rectè eſſe delineatam, in Cometâ 1652, undè conſtet.], 594.
    - to assume the path correctly matters very much [ritè ſupponere,plurimùm intereſt.], 629.
- The trace of the path: when it touches or cuts the annual orbit, or when it leaves it untouched, the method of calculation is not one and the same [Trajectorium veſtigium, quando Orbem annuum tangit, aut ſecat, vel cùm intactum eum relinquit, non eſt una eademq́; calculi ratio.], 595.
- The motion along the path is never uniform in comets [Trajectorius motus nunqu. in Cometis eſt æqualis.], 751.
- By what method the motion along the path can be preserved even with the Earth at rest [Trajectorius motus, quâ ratione terrâ etiam ſtabili conſervari poſſit.], 589.
- A trumpet-shaped comet [Tubiformis Cometa.], 445.
- Where the swelling of tails comes from [Tumor Caudarum unde.], 508.
- Tycho held the angle of inclination to be invariable [Tycho Angul. inclinat. invariabilem ſtatuit.], 113, 116.
    - Tycho Brahe was the first of all to observe and describe comets properly [Brahæus primus omnium Cometas ritè obſervavit, atq́ue deſcripſit.], 452.
    - Tycho and Rothmann observed the comet of 1585 diligently [& Rothmannus Cometam 1585 ſedulò obſervarunt.], 619.

- Tycho erred very little in determining the parallax of the comet of 1577 [in definiendâ parallaxi Cometæ 1577, minimè aberravit.], 618.

- The Author does not agree with Tycho about the curvature of tails [Tychoni Auctor de Caudarum curvaturâ non adſtipulatur.], 493.
- Tycho's description of the comet of 1577 [Tychonica deſcriptio Cometæ 1577.], 452.
- Tycho's opinion on the curving of comets [Tychonis de Cometarum incurvatione ſententia,], 493.
- Tycho's notes on the new star that arose in Cassiopeia [Tychonis de novâ Stellâ in Casſiopeâ exortâ annotationes.], 375.
- Tycho's opinion on the direction of tails [Tychonis de directione caudarum ſententia,], 462.
    - Tycho's and Cysat's method of deriving parallaxes [& Cyſati parallaxes deducendi ratio.], 285.
    - Tycho's judgement on his own orbicular theory [Judicium de Theoriâ ſuâ orbiculari,], 616.
    - Tycho's sizes of the planetary orbs [Magnitudines Orbium Planetarum.], 714.
- Tycho's method demonstrates only probable parallaxes [Tychonis Methodus, probabiles tantùm parallaxes demonſtrat.], 288.
- Tycho's observation of the motion of the inclination of the orbit in the comet of 1585 [Tychonis Obſervatio de motu inclinationis Orbitæ in Cometâ 1585.], 119.
- Tycho's reasons by which he most strongly proves that a comet performs its motion under a great circle [Tychonis rationes, quibus maximè evincit Cometam ſub circulo maximo exercere Motum.], 133.
- Tycho's opinion on the deviation of the cometary tail [Tychonis ſententia deDeviatione caudæ cometicæ.], 486.
- Tycho's opinion on Regiomontanus's method of finding parallaxes [Tychonis ſententia de Methodo Regiomontani eruendi parallaxes.], 295.
- Tycho, above others, gave careful attention to parallaxes [Tycho præ aliis ſollicitè parallaxibus dedit operam.], 138.

V.

- The distinguished Boulliau also holds that there are vapours around the Moon [Vapores circa Lunam dari, etiam Cl. Bullialdus ſtatuit.], 367.
- Lunar vapours are much thinner and purer than solar and terrestrial ones [Vapores Lunares, Solaribus & terreſtribus multò ſunt tenuiores ac puriores.], 363.
- The variation of motion of different comets is not the same [Variatio motûs diverſorum Cometarum non eſt eadem.], 690.
- Whether the variation of a comet's motion depends on the inclination [Variatio motûs Cometæ, an ex inclinatione dependeat ?], 691.
- Comets are subject to almost infinite variations [Variationibus,Cometæ obnoxii ſunt penè infinitis.], 321.

- The primary cause of the variation of cometary motion [Variationis motûs cometici primaria cauſa.], 693,694.
- The vastness of the cometary body of 1652 [Vaſtitas corporis cometici 1652.], 334.
- With longer levers and rods, larger and heavier loads are moved [Vectibus & ſcytalis longioribus, majora & graviora moventur onera.], 645.
- What the lever and the fulcrum are in statics [Vectis & fulcimentum, quid ſit in Staticis.], 577.
- A lever always needs a point of rest, or a fulcrum [Vectis, quiete ſemper, ſeu fulcro opus habet.], 578.
- The requirements of sailing [Velificationis requiſita.], 578.
- How great the speed of comets is according to the Ptolemaics [Velocitas Cometarum juxta Ptolemaicos quanta ?], 707.
- The speed of the planets in their orbs [Velocitas Planetarum in ſuis Orbibus.], 703.
- The greatest speed of comets on the hypothesis by tangents does not agree with the observations [Velocitas maxima Cometarum ex hypotheſi per tangentes,Obſervationibus non reſpondet.], 784.
- How great the highest speed of comets is [Velocitas ſumma Cometarum quanta ?], 700.
- The limits of the speed and the slowness of comets [Velocitatis, & tarditatis Cometarum limites.], 705.
- Weathervanes imitate the motion of plane-shaped bodies [Ventorum indices æmulantur Motum corporum planiformium.], 586.
- Why Venus has at times changed its colour, shape and size [Venus, cur Colorem,Figuram & Magnitudinem aliquando mutaverit?], 373.
- Venus, Mars and Mercury also have their own attendants [Venus,Mars & Mercuri9 ſuas etiam habẽt aſteclas.], 372.
- Spinning and whirling produce a remarkable motion and impetus [Vertigo & circumgyratio inſignem excitat motum atque impetum.], 645.
- The Spit, or Pole [Veru, ſeu Pertica.], 440.
- The trace of the comet of 1665 fell above the sections of the lines of sight, and within the annual orbit [Veſtigium Cometæ 1665 ſupra ſectiones viſoriarum, & intra Orbem annuum incidit.], 768.
- The longitude of the trace is sometimes the same as the longitude of the line of sight [Veſtigium longitudinis, nonnunquam idem eſt cum viſoriâ longitudinis.], 639.
- The ancients neglected comets [Veteres, Cometas neglexerunt.], 437.
- The ancients observed comets very meagrely [Veteres, jejunè admodùm Cometas obſervarunt.], 452.
- The method of the old and most ancient authors for distinguishing comets [Veterum & antiquisſimorum Auctorum Cometas diſtinguendi ratio.], 438.

- The various opinions of the ancients on comets [Veterum Opiniones variæ de Cometis.], 351.
- The various ways of finding parallaxes [Viæ, parallaxes inquirendæ, variæ.], 165.
- The travelling path of a comet is in part curved, according to the impressed motion and the inclination of the disc [Via itineraria Cometæ ex parte eſt incurvata, pro motu impreſſo, & inclinatione diſci.], 588.
- By what means above all the vibration of the tail comes about [Vibratio caudæ,quâ potiſſimùm ratione procedat.], 510.
- Where the vibration and fluctuation of tails come from [Vibratio & Fluctuatio caudarum unde ?], 508.
- How the vibrations and flickerings of tails are produced [Vibrationes & Micationes caudarum, quâ ratione excitentur.], 512.
- The vibrations, fluctuations and leapings of tails are not always the same [Vibrationes, Fluctuationes, & Subſultatiõnes caudarum non ſemper ſunt eædem.], 512.
- In which comets' tails the vibrations of the rays are more frequent [Vibrationes radiorum in quibus Cometarum caudis ſunt frequentiores.], 512.
- What the true account of the vibration and fluctuation of tails is [Vibrationis & Fluctuationis caudarum vera ratio quænam.], 510.
- Small forces move great weights with a lever [Vires exiguæ, vecte movent magna pondera.], 578.
- Where the lines of sight are oblique to the path, the comet is mostly nearer the Earth [Viſoriæ ad Trajectoriam ubi ſunt obliquæ, Cometa plerumq́; terræ eſt propior.], 640.
- Whether the shadow of some planet or of the Earth can obscure a comet, and at what time this can happen [Umbra alicujus Planetæ vel Terræ, an Cometam obſcurare, & quo tempore id fieri poſſit ?], 551.
- The shadow of the comet of 1652 exceeded the shadow of Mars [Umbra Cometæ 1652 Martis umbram ſuperavit.], 551.
- Whether the shadow of comets can overshadow or eclipse the stars [Umbra Cometarum, an Stellas inumbrare vel eclipſare poſſit?], 548.
- The shadow of comets by no means produces the tail [Umbra Cometarum caudam neutiquam efficit.], 544.
- The shadow of comets can be now longer, now shorter than the tail itself [Umbra Cometarum modò longior, modò brevior ipsâ caudâ eſſe poteſt.], 545.
- The shadow of comets can at times overshadow the planets [Umbra Cometarum Planetas quandoq́ue inumbrare poteſt.], 548.
- How the shadow of comets can obscure the stars [Umbra Cometarum, quomodo Stellas obſcurare poteſt.], 548,549.
- How great the shadow of certain comets was [Umbra Cometarum quorundam, quanta extiterit.], 550.

- The shadow of comets is always fainter than that of the planets [Umbra Cometar. ſemper eſt dilutior Planetarum.], 544.
- The length and shape of a comet's shadow [Umbræ cometicæ Longitudo, & Figura.], 545.
- Solar shadows and faculae are fainter the farther they stand from the body of the Sun [Umbræ Faculæq́; Solares, quò à Corpore Solis diſtant remotiùs, eò ſunt dilutiores.], 498.
- The length of the shadow of any planet (the Moon excepted) is far smaller than the interval even of the nearer planets [Umbræ longitudo cujuscunque Planetæ (exceptâ Lunâ) longè eſt minor, quàm intervallum viciniorum etiam Planetarum.], 550.
- Solar shadows, spots and faculae are subject to continual changes [Umbræ, Maculæ, Faculæq́; Solares, continuis obnoxiæ ſunt mutationibus.], 508.
- Why the greater part of the shadow lies hidden in the part turned away from the Sun [Umbræ major pars, in parte Soli aversâ, cur deliteſcat ?], 480.
- The shadows of the planets are smaller than their intervals [Umbræ Planetar., minores ſunt eorum intervallis.], 549.
- Shadow can contribute nothing to the length, but something to the brightness of the tail [Umbra nihil quidem ad Longitudinem, ſed ad claritatem caudæ conferre aliquid poteſt.], 548.
- Shadow: when and how it precedes a solar spot, and again follows it [Umbra, quando & quâ ratione Maculam Solarem præcedat, rurſusq́; ſequatur.], 479.
- A secondary shadow on the Sun sometimes subtends, at a certain distance from the Earth, 70° and more [Umbra ſecundaria in Sole nonnunq. in certo à Terrâ intervallo 70 & amplius grad. ſubtendit.], 481.
- The Author observed remarkable shadows and faculae on the Sun [Umbras & Faculas in Sole Auctor conſpexit admirandas.], 478.
- The size of solar shadows, if they were in the lunar orb [Umbrarum Solarium Magnitudo, ſi in Orbe verſarentur Lunari.], 481.

W.

- Walther's observation of the comet of 1472, made at Nuremberg [Waltheri Obſervatio Cometæ 1472, Norimbergæ habita.], 540.
- Wendelen's and Kepler's parallax of the comet of 1618 was imperceptible [Wendelini & Kepleri parallaxis Cometæ 161 8 fuit inſenſibilis.], 878.
- Wendelen's observation of the comet of 1607 [Wendelini Obſervatio Cometæ 1607.], 873.
- Wendelen's observation of the comet of 1618 [Wendelini Obſervatio Cometæ 1618.], 878.
- Wendelen testifies that four comets were seen at the same time in the year 1618 [Wendelinus teſtatur, quatuor ſimul Cometas anno 1618 viſos eſſe.], 876.

X.

- The Xiphias comet [Xiphias Cometa.], 811.

Z.

- A zodiac does not belong to comets [Zodiacus Cometis non competit.], 434.
- Solar spots have their own zodiac [Zodiacum ſuum habent Maculæ Solares.], 409.
- The zones, or belts, of Jupiter [Zonæ, ſeu faſciæ Joviales.], 371.

Errors [ERRATA.][710]

Page [Pag.]	Line [Lin.]	Error [Menda.]	Correct thus [ſic emenda.]
5	5	peracta	peractæ.
18	37	altitudibus	altitudinibus.
20	3	&	ex.
87	29	Declinationis	Declinationum.
88	27	M H L	H M L.
88	28	Latitudo	Declinatio.
107	20	ſit ut	ſic ut.
111	margin [Margin.]	Orbitiæ	Orbitæ.
129, 130	2	Vrametis	Tramitis.
154	margin [Margin.]	Diverſiſitatem	Diverſitatem.
154	margin [Margin.]	neutiqua	neutiquam.
177	11	ſi qua	ſi quæ.
322	third from last [antepen.]	8 Junii	8 Januarii.
445	Figure F [Fig. F.]	aliter eſt exhibi indicatum eſt,	ta, quàm eâdem pag. quâ de re lege pag.772.
456	40	Berenices	Bootis.
456	41	Auſtro	Arcturo.
465	19	F C	F B.
527	margin [Margin.]	axiomdta	axiomata.
527	same place [ibidem]	videna	videnda.
527	same place [ibidem]	longisaſima	longisſima.
546	margin [Margin.]	fundi	fundæ.
549	Table V [Tab. V.]	ad num. 3 infra	f L adjiciatur I.
592	32	X E P A B C	X Q P A B C.
727	27	37° 5′ 30″	39° 5′ 30″
745	8,10&c.	April.	Februarii.

Page [Pag.]	Line [Lin.]	Error [Menda.]	Correct thus [ſic emenda.]
751	37	animaverſum	animadverſum.
756	margin [Margin.]	1662	1664.
757	36	40° 13′ 17″	30° 13′ 17″.
765	63	1190	190.
765	70	4	174.

[710] The list is printed as one ruled table in two blocks set side by side, each with the same four columns; the left block is given first, then the right.

Page [Pag.]	Line [Lin.]	Error [Menda.]	Correct thus [ſic emenda.]
768	margin [Margin.]	ſequitur	concordat [[c/e/o]]um. [?]
777	margin [Margin.]	deflectet	deflectat.
795	10	Spira	Spiræ.
802	23	Genitricis	Genetricis.
804	40	morerétur	moriretur.
804	margin [Margin]	auro	anno.
805	17	viciniis	vicinis.
819	last line [lin. ult.]	anno C.	anno C. 1066.
824	margin [Margin.]	uſpectos.	ſuſpectos.
826	margin [Marg.]	pſe	ipſe.
827	15	Crancrum	Cancrum.
827	25	orerétur	oriretur.
832	margin [Margin.]	trrrs	tres.
851	6	iſtius ſyderis	iſtud ſydus.
851	margin [Margin.]	1566	1556.
866	margin [Margin.]	Curusq́;	Curſusq́;.
883	7	pelluceretur	pelluceret.
894	margin [Margin.]	major	majus.
895	41	longior versùs	dele versùs.
944	47	1872	1472.

711

If any others have perhaps crept in, I ask again and again that they be kindly removed. [Si quæ alia fortè irrepſerint, ut benevolè tollantur, etiam atque etiam rogo.]

[Blank page. Beyond the gutter, on the edge of the facing page, modern notes in pencil: at the head, 43[?] and below it 23[?], both cut off at the edge of the scan; along the gutter, written sideways, [[A/Λ]][[1/l]] 24je[[6/b]][[9/q]].]

[Paper within the turned-in vellum of the back board, with modern pencil notes: at the upper left, 130[[4/7]].[[1A/M]] and below it 3 My [[4/d]][[4/9/q]]; across the upper part, Hevelius, JohANNes, 1611-168[[7/4]], with 1[[1/l]] beneath it; at mid-height, in four lines, QB721 /.H5 / RAre B[[k/K]] / Coll.]

[Outside of the back cover: yellow vellum over the board, scratched and stained, with no title, label or writing; at the left the fore-edge of the book block, at the right the joint and the edge of the spine.]

[711] Three entries give instructions rather than a simple replacement. For p. 445, Figure F, the two last columns and the following line run as one sentence: Figure F is shown otherwise than is indicated on the same page; on this matter, read p. 772. For p. 549, Table V, the error column reads at no. 3 below, and the correction directs that I be added (adjiciatur, let it be added). For p. 895, dele means delete. In the entry for p. 768 the first letter of the last word of the correction is filled with ink and cannot be told apart.