

Sefer ha-Techunah

ספר התכונה

[The Book of Astronomy]

(1866 (first printing of the work; this copy is far earlier — see Date below))

by R. Chaim Vital (חיים ויטאל, 1542–1620)

Translation by Scott Weisman



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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

A manuscript copy of R. Chaim Vital's treatise on astronomy, written in a rabbinic hand in Damascus in the early seventeenth century — the city where its author spent his last two decades, and within a generation of his death. Its seventeen astronomical diagrams are executed in gold, red and blue with titles in gold. Two eighteenth-century Damascus kabbalists signed the opening leaf. It is the earliest known witness to the text.

What this volume contains, against what its author said he would write. Vital's preface sets out four parts: the premises of the science; the making of the tables; the manner of making them; and the molads, tekufot and fixings derived out of the tables written in the second part.

This manuscript carries the first part alone, ending at f. 43r with the colophon ע"כ שער הראשון — "Thus far, the First Gate." The three tabular parts are not here, and the argument points forward to tables it never supplies. At f. 20r the author sends his reader to "the tables which we copied from" a named predecessor, so those parts were to be tabular, and taken from an earlier astronomer rather than computed afresh. Read this as a complete first part, not a complete book.

The text and its apparatus. The base is Chester Beatty Ms. Heb. 762, written in Damascus in the early seventeenth century and the earliest known witness. Every reading in the body is the manuscript's. Collated into the apparatus is the printed tradition, in a modern resetting of the first printing (Jerusalem, 1866), together with the notes its own editors and annotators left at hard places. The print has nowhere been allowed to alter the manuscript's text. Where the two differ, both readings stand.

Conventions. [...] encloses a reading the manuscript leaves open, with the competing possibilities shown; [recte: ...] is a correction, committed to a specific reading; [?] marks what could not be read. Scriptural and rabbinic references follow the brackets: (**Tehillim 1:1**) means the reference is written in the source; [**Tehillim 1:1**] means we supply it from the phrase, and no reference stands on the leaf. That distinction matters more than it looks — a phrase recognised and a reference read are different evidence, and a misread word will pull a plausible wrong verse in behind it.

A NOTE ON THE TRANSLATION PROCESS

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

This edition has been checked at citation grade. A stratified sample of it was independently re-transcribed from the original page by readers given no sight of the translation, and the two readings were then reconciled letter by letter. Every disagreement in the layer a citing reader depends on — figures, names, headings, and whether a passage is present at all — was settled against the page before publication, and none was left open.

What that does and does not mean. It is a claim about a sample, not about every line. A passage the sample did not reach is neither confirmed nor denied,

and silence in an independent reading is not agreement. Where the page itself will not settle a reading, this edition withdraws rather than guesses: a bracketed pair marks a genuine ambiguity the original cannot decide, and a question mark a character that could not be read. Those marks are deliberate refusals, and they are worth more than the confident readings they replace.

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

Translated with the assistance of Claude. The translator thanks the Anthropic team for making this work possible.

[Margin: outer (left) margin, upper half — two short inscriptions in a smaller, more cursive hand later than the scribe's, in a browner ink; the upper cluster of three lines opens with what reads as חנני אלהים [?], the lower cluster of two lines is not resolvable. Both are partly covered by conservation tissue laid over the leaf. Content not legible at this resolution — [?]. No name is legible in either.]

[Red ink display: ספר התכונה מהמהרח"ו זלה"ה]

Sefer ha-Techunah, by Maharchu [R. Chaim Vital], זלה"ה [may his memory be for the life of the World to Come].

Sha'ar 1 שער א, in gold]

A memorandum. The lunar cycle of nineteen years י"ט — in which there are seven months more, on account of [?] — comes to six thousand nine hundred and thirty-nine days, sixteen hours, and five hundred and ninety-five chalakim [parts, each 1/1080 of an hour], reckoned out of the 1,080 מתת"ף to the hour. These are the sum of nineteen years [?] ... according to Rav Ada, whose year is 365 days שס"ה, five hours, nine hundred and ninety-seven chalakim, and forty-eight regain — seventy-six משבעים וששה regain to every chelek — by the precise reckoning of [?].

Examine it closely and you will find it so ודוק ותשכח.

Since in every cycle hours and chalakim are left over, and we do not count them [?] except in whole days, [?] when they amount to [?] we add a day [?], according to the known rules. And if [?] beyond the cycle [?], they will not be [?]; and if [?]

in the second [?] there will be [?] from the gathering of the hours and the chalakim that remained from them, together with the hours and the chalakim [?] that are left over from the reckoning. And the remainder [?] that is added [?]; and so one returns again with what remains [?]. And if [?], we do not add a day until the next cycle.

And by the known rules, by which one knows the molad [conjunction] and the deficient [?] and the [?] true — except that the remaining [?] [?] to know — until he has reckoned for every cycle its days and its chalakim, [?] as was explained above. And in this way he will know how many days have passed from the creation of the world until this day, [?] so that he may reckon every year [?], to know whether it was deficient חסרה [?] or full שלמה; and by the [?] rules [?].

the molados [?] upon the molados [?] this rule, for [?] the ikkar [the epoch from which the computation runs] anew [?], after the manner of what [?] did [?] ... זלה"ה, the day of the ikkar [?] for every sphere and for every planet. All this [?] to apportion to every [?] ...

Know why [?] cycles that have in them [?] days and not [?] alone, for they could not be so forever [?]. And by this reckoning [?] the [?] of the two [?] ... days; and this [?] is [?] to say [?], for we have [?] one day in several cycles, and according to [?]

the whole rule of the dechiyos [the postponements by which the calendar is regulated] we cannot add [?] in the [?] cycle [?]; the whole [?] and by the

[?] together with what is added in the cycle [?] two days. And the matter [?] except by the precision of the reckoning of [?]; and [?] that so it is in truth, [?] for we have found cycles [?], and from them we found that [?] they are [?] added [?] cycles. Therefore the whole rule of the dechiyos must be thus, and these [?] [?] all the hours and the chalakim [?] they are the ones added in [?].

the cycles, which are [?] and not [?]. And apart from the [?] left over upon the cycles of four [?] that are added to them — that is, only [?] ... and that of the first cycle is ל"ו[?], and the second is ל"ו[?], and there remains of them [?] hours, and further [?] the third and the fourth [?] ... ל"ו[?]; and what remains of them is about ל"ו[?] hours and more. And in all of them the cycle [?] [?] the first [?] ... and the [?], and they were [?], and further they are [?] more than [?] hours, which are more than six days [?] ... [?] hours; and [?] their being in the place of ל"ו[?], six days and more, which are מ"ו[?]; and there remains of them a further [?] hours [?].

And all that you do by the correct reckoning is to know [?] the year — whether it is deficient [חסרה], regular [כסדרה] or full [שלמה] — and therefore [?] one postpones [דחה] and sanctifies [the new month]. : :

אמר [in gold] — Thus says the humble one [הצעיר] Chaim [חיים] Vital[?] [[כמוה"ר]] R. Yosef [יוסף] Vital[?] [[ויטא / ויטאל]], son of [?] the honoured Rabbi and teacher [[כ"ב]] because [?] ...

to reckon [?], and at the outset [?] ... [?] and molados and the intercalation of the years [עיבור השנים]; and this labour was [?] ... [?] to reckon the tekufos [the sun's seasonal turning-points] and the molados, and it does not [?] upon us [?] ... as Scripture says, "and the work of the Lord they did not regard" [ואת פעל ה' לא הביטו] [Yeshayahu 5:12]¹ — and not [?] ... [?], for I shall [?] [?] the work of [?] ...

And so too we have found [?], we have seen [?] ... And thus were the astronomical schemes of Shmuel and of Rav Ada, each one according to his own [?] ... who occupied themselves with this science [?] ... to know it thoroughly [על בוריה]; and [?], for the essence of this labour is to know the course of the sun and the moon and their tekufos [?] ... for through this the fixing of Rosh Chodesh and of Yom Tov becomes known to us, and how many labours depend upon this matter. In any case, since [?] ... [?] the course of these two luminaries, we shall be able to know the courses of the other planets [?] ... [?] and little; and just as [?] in the matter of the tables of the courses of the sun and the moon — for from them you will easily be able to stand upon the knowledge of the other five planets [?] — so as to reckon [?].

Now, others besides me have [?] [?] ... a work small in quantity and great in quality. And so I shall compose most of the premises needed to [?] ... [?] the said science, and by a short road, so as to [?], not [?] ... [?] his hand sufficed to compose the [?] books ... [?] who occupy themselves with this science. And we have divided it into [ד'ג'] derushim [inquiries]: : :

¹the leaf writes הביטו; the received text has יביטו

The first derush will be the exposition of certain premises concerning the sphere of the earth and the encompassing sphere[s] [?], [?] and the stars that are in them and their courses. ::

The second derush: [?] — the tables required in order that the courses of the luminaries [?] and the stars and [?] be known; [?] ... [?] so that the molados and the tekufos and [?] and the fixing of Rosh Chodesh and Yom Tov may be known to you. ::

The third derush: [?] — the tables, and they shall not be like [?] "the sealed book" [הספר החתום] [Yeshayahu 29:11]. ::

The fourth derush [הד']: [?] — the molados and the tekufos and the fixings [?] ... [?] and the order of the year, and the courses of the planets [כוכבי לכת] and the constellations [מזלות], and how we may know the fixing of [?] ... [?] them and their matter out of the tables, as they are written at the head of [?] ... the year [?] ... [?] all this, with the help of Heaven [בע"ה]. ::

[Margin: outer (left) margin, on the same line as the running header — the folio numeral ב (= 2), in the scribe's own hand and ink. Higher in the same margin, a pale grey mark shaped like a hooked stroke; it recurs at the mirrored position on the verso, so it belongs to a repair or a conservation mark on the leaf rather than to either text side.]

Sha'ar I [השער הא', the first word in gold] — the exposition of premises concerning the sphere of the earth, the spheres, the stars and their courses; and it contains eighteen chapters [י"ח פרקים]. ::

Chapter I [פרק א', in gold] — the exposition of the sphere of the earth: of what lies around it and upon it, and of how all the spheres revolve, to give light to [?] upon it and to pour down influence [?] upon them, as their Creator, blessed be He [?], commanded them. ::

Know [דע, the opening ד in gold] that the earth is round like a ball on every side [?], and is not flat, nor square, nor of any other shape.

It is established, further, that any sphere that is round admits of division in three ways [בג' חלקים] — the numeral is a single letter and I could not separate ג from ד. The first is this: when you cut the sphere in half and set one half above and one half below, there comes to be there a single line cutting it in two, and this line the scholars of astronomy call, in the language of [?], the line of the horizon [קו האופק]. [?] When you cut it in half from its east [?] to its west [?], [?] one half to the south and one half to the north, there comes to be there a line cutting it, which is called the equinoctial line [קו השווה]; they also term it the line that equalizes the day [קו המשווה היום]. The third is when we cut it in half from north to south and set one half to the east and one half to the west; then there comes to be there a line [?] — the meridian [קו חצי היום].

And in the second chapter [ובפרק הב'], in the exposition of the orb [בביאור גלגל] [?], we shall explain the names of these lines; for there, in the first orb [בגלגל הא'], which is called the diurnal orb [גלגל היומי], [?] these names [?] for every [?] — they are called [?], and so for the rest. ::

Know that the whole extent of the inhabited region on this sphere, in which we stand, is no more than the upper northern quarter [כרביע העליון הצפוני] of the sphere of the earth. It begins at the equinoctial line on this sphere [?], and spreads and runs on as far as the line of the horizon on the small sphere [?]; and together with [?] it runs from below as far as the equinoctial line at the base of the sphere — like the lower quarter [כרביע התחתון] of the [?]. [?]

In the southern part of the sphere there is no habitation whatever, because of the great heat there, since the line of the sphere of the sun spreads out there toward the south, and [?] ... before us, in the matter of the sphere of the sun, as the early authorities determined [כפסק הקדמונים].

The later authorities have written that they have already found and seen great settled regions besides this settled region of ours, over the whole surface of this sphere [?] ... as the motions of [?] ... [?].

Know [ודע, the opening ד-ו enlarged] that this inhabited part, in which we are, the early astronomers divided into seven parts [ל' חלקים], and they are called the seven climes [אקלימים], for they are like portions and bands encircling

Diagram. A circle drawn in gold, set into the left-hand two-thirds of the text block; the body text of lines 14–24 is shortened on the left to make room for it, so the figure sits within the writing area rather than over it. A single gold diameter runs horizontally across the full width of the circle, with a small gold node marked at the centre. In the right-hand portion of the circle, gold chords are drawn perpendicular to that diameter, running from the upper arc to the lower arc — I count eight of them, but the count is a floor, not a certainty: the two nearest the right-hand arc are close-set and I would not swear to the separation. Between the chords, below the horizontal diameter, the scribe has written a row of small labels set vertically (rotated 90°), each occupying its own strip; above the horizontal diameter, at the head of the chords, stands a row of small single letters. All lettering on the figure is in the scribe's brown-black ink. No red and no blue appear on this figure — the gold is the only colour, and it carries the whole construction (circle, diameter, chords).

Labels legible on the leaf, as drawn:

- מערב (outside the circle, centred above the top of the arc) — west
- מזרח (outside the circle, centred below the bottom of the arc) — east
- דרום (outside the circle, at the far left, set vertically) — south
- אופק (inside the circle, written along the upper-left arc and following its curve) — horizon
- קו חצי היום (written horizontally along the horizontal diameter, to the left of the central node) — the meridian
- צפון (outside the circle, at the east end of the horizontal diameter, set vertically) — north.²

²read on ink in both witnesses; see the plate-label QA note below.

- מרכז הארץ [recte: מרכז הארץ, superseding the earlier [?] הארץ / conjectured [קר כדור הארץ] (inside the circle, upper middle-left, the legend set diagonally along the curve) — the centre of the earth.³
- the row of small single letters above the diameter: a numeral series 1–7 counting outward from the axis. The series is now independently confirmed; three of its seven sorts are still supplied from the series, not read from the ink (see QA below).
- the vertical labels in the chord-strips below the diameter: אקלים [recte: אקלים, superseding the earlier reading חלקים] — "clime" — written identically in each of the seven compartments. This makes the figure a clime diagram.⁴

[Margin: outer (right) margin — no folio numeral. The brown mark standing in that margin at the height of the header is the ghost of the recto's ב, showing through the leaf; it is not writing on this side. Lower down, over the outer edge of the text block, a faint grey circular library stamp; its legend is not legible at this power. A pale grey hooked mark stands in the upper outer margin, mirroring the one on the recto.]

— encircling [?] the small sphere, round about, [?] above.

It is established that a round sphere has in it length [אורך] and breadth [רוחב]: [?] the figure of the [?] is [?] upward, and breadth runs from south to north. And these seven climes are divided across the breadth of this part of the sphere, from the equinoctial line — which already cuts it in half — upward, as far as the limit of [?] of the sphere on the northern side. And the first [?] begins from the first portion, the one adjoining the equinoctial line; and the [?]. The second clime stands further from the equinoctial line than the first, toward the north; and so on, until we find that the seventh clime is nearly [?] of the sphere. Above the equinoctial line its rise reaches a measure of [numeral: ?] ב" degrees and a half, and toward the north lies a region empty of all habitation, which is not reckoned among the seven climes.

And from there onward [ומשם ואילך] is the beginning of the seven climes, as mentioned.

At the [?] of the seventh clime, from there onward, there is little habitation; there are no [?] there [?], nor forms, because of the great cold. This is a measure of about [numeral: ?] degrees [?] minutes, and it is not included among the seven climes. From there onward, as far as the edge of the north, there is no habitation at all. And [?] — all this below, in the division of [?] [?].

The length of the climes runs from east to west, encircling the sphere above and below exactly; and the breadth that [?] this clime runs from [?] north to south.

Know that the length and the breadth of the seven climes are not [?]. The first, being nearly [?] of the sphere, is longer than the rest of the climes; and

³eight sorts, exact. The same phrase stands in the hub of fig-p18-1 on f. 9v, read there independently.

⁴the superseded חלקים ("parts") stands verbatim in the QA notes below; not deleted.

in the same way the length of each clime diminishes from that of its fellow, down to the seventh clime, which is at [?] of the sphere, and [?] the rear [?] of the sphere — and it is therefore shorter above and below, as is the case with the breadth, except that [?] ... [?] for the whole thickness [?] to the aspect of breadth, divided one from another. And a scholar has no [?] [?] before us, and [?].

It is found, then, that the localities [מדינות] and the measures proper to each clime, or [?], have length and breadth differing one from another. For a locality that lies in the second clime is further from the equinoctial line than a locality in the first clime, which is near the equinoctial line. And this distance, by which the locality stands away from the equinoctial line, is called the latitude of the locality [רוחב המדינה]; and in proportion as the locality stands further from the equinoctial line, [?] increases.

And the longitude of the locality [אורך המדינה] is [?] the measure of its distance from the meridian, and onward [?], whether toward the east or toward the west — except that for a locality lying to the east of the meridian, its longitude is reckoned as the lesser distance, from the eastern horizon toward the meridian, and this is called eastern longitude [אורך מזרחי]. So it is found that a locality close to the eastern horizon has a small longitude, and the nearer the locality lies to the meridian the greater its longitude grows. So too with the localities lying to the west of the meridian: [?] its longitude runs from the western horizon toward the meridian; and every locality near the western [?] horizon has a smaller longitude than a locality near the meridian on its western side. And this is called western longitude [אורך מערבי].

Now according to this, there are localities that have neither —

[Margin: outer (left) margin, on the line of the running header — the folio numeral 3 (= 3), in the scribe's own hand and ink. Above it, in the head margin at the extreme outer corner, a modern pencil 3. Standing in the same outer margin, lower down, two pale grey marks — a hooked stroke and a broken ring — of the same kind noted on the two preceding leaves; they are pale, they are in the substance of the paper rather than on its surface, and they show at mirrored positions on both sides of the leaf, which is what a watermark does and what surface ink does not.]

— neither longitude nor latitude. That is the locality situated on the sphere [?] at the point where the equinoctial line and the meridian meet.

Others have both longitude and latitude: the localities that lie far [?] from [both lines] [?].

Others have longitude but no latitude: the localities that adjoin the equinoctial line [?].

And others have latitude but no longitude: the localities that stand on the meridian and are distant from the equinoctial line toward the north [צפון] — see the QA note; צפון and קטן are not separable in this hand at this power], and not [?].

To know the measure of the longitude and the latitude of every locality you must first know the measure of the sphere of the earth. The matter is this. Just as the sphere [?] is divided into [twelve constellations [?]], and each [constellation] into thirty degrees, so that the circuit of this sphere's revolution comes to 360 degrees [ס"ש] — from one degree to the next [?] — from north to south, so too [?] the sphere of the earth is divided [?] into 360 degrees, matching the circuit of the sphere's revolution from east to west; and likewise from north to south.

Since the circuit of the whole sphere is 360 degrees, the circuit of half the sphere will accordingly be 180 degrees [פ"ק]. These run from the point of the eastern horizon line to the point of the western horizon line in the upper half of the sphere; and corresponding to them are another 180 degrees in the lower half of the sphere, running from the point of the western horizon line to the eastern horizon line.

By the same reckoning a quarter of the sphere will be 90 degrees [צ']: [?] from the eastern horizon line to the meridian at the [?] of the sphere is 90 degrees; from there to the western horizon line, 90 degrees; from there to the meridian at the bottom of the sphere, 90 degrees; and from there to the eastern horizon line, 90 degrees.

Corresponding to these there are [numeral: ?] degrees in the circuit of the sphere of the earth from south to north — 180 degrees in its upper half and 180 in its lower part. They run as follows: 90 degrees from the southern horizon line to the equinoctial line on the upper side of the sphere; from there, 90 degrees to the northern [?] horizon; from there to the equinoctial line at the bottom of the sphere, 90 degrees; and from there to the southern horizon, 90 degrees.

Now since the place of our habitation is one part [?] [of the sphere], and lies only toward the north as already stated, it follows [?] that the latitude of localities has a measure of 90 degrees, counted from the equinoctial line to the northern [?] horizon — with another 90 degrees corresponding to them, from the northern [?] horizon to the equinoctial line at the bottom of the sphere.

The longitude of localities, then, is found to be 180 degrees [?], since [it runs] from the eastern horizon to the western horizon across the whole [?] inhabited [region] — that is, the circuit of the upper half of the sphere — with another 180 degrees of longitude corresponding to them [?] in the lower half of the sphere [?].

Although the measure of longitude is 180 degrees, [?] because it is divided [into two [?]] — into eastern longitude and into western longitude, as stated — we therefore say of longitude [?] that it holds no more than 90 degrees. So it is found that the localities to the east of the meridian [run] [?] up to 90 degrees only, and corresponding to them another 90 degrees of western longitude, for the localities standing to the west of the meridian, as far as the [western] horizon —

[Margin: outer (right) margin — no folio numeral, as expected on a verso. The same two pale grey marks stand here that stand on the recto, at the mirrored position: they are in the paper, not on it, and they read through from both sides. Nothing else in this margin except the gloss noted below.]

— western [horizon]. Know, further, that the Ocean [ים אוקיינוס] surrounds the sphere of the earth, as is well known. The number [?] of degrees of longitude, therefore, for the localities in the upper half of the sphere, are counted from the eastern horizon to the western: from the shore of the eastern [?] sea that adjoins the sphere of the earth, as far as the shore of the western sea that adjoins the sphere of the earth.

Know, too, that the astronomers apportioned [?] all the localities in every clime, and set down the longitude and latitude of the city of Jerusalem [ירושלם ת"י] — for earlier, in the matter of the molados and the tekufos and the chalakim [?], and as you will see, with God's help, [?] — [?] they are all founded upon her [?], as it is written [?].

[?] said that Jerusalem stands at the middle [?], fixed [?], of the world. And [?] to say the reverse [?], that it would lie to the north [?] —

The reason is that Jerusalem lies at the middle of the inhabited world, at the edge [?] of this [?] clime, which [?] — in the north of the sphere, as mentioned. It stands at the end of the third clime [האקלי' הג'], adjoining the beginning of the fourth. And the latitude [?] of the first clime is close to the latitude of all the [?] — so that the latitude of Jerusalem, reckoned from the equinoctial line toward the north, comes to [numeral: ?] degrees [?].

There is a disagreement here. According to the view of the author of [?], [Jerusalem] is distant from the near west [?] — reckoned from the near islands in the Ocean, such as the isles of [?] — [?] degrees. But there are other islands further off, on the [?] side [?] of the west, in the Ocean, and this is called the far west; and the distance of Jerusalem from that far west [is ...].

And know that the longitude of Jerusalem from the near west, toward the meridian, is 83 [פ"ג] degrees [?]; and from the far west, 85 [פ"ה] degrees. So it is found that the latitude [?] of Jerusalem is 33 [ל"ג] — the second letter is ג or ב, i.e. 33 or 32; not separable] degrees. [?] from the far west, 83 degrees and a half; and therefore [?] 85 [?].

[Margin: right margin, alongside these lines, in a second hand — smaller, thinner, greyer ink and markedly more cursive than the scribe's. Two short lines. What is legible: ... ואורך on the first, רחב on the second, the rest not resolved. I make no identification of it beyond that; it stands beside the passage on the longitude and latitude of Jerusalem.]

And its longitude according to Ptolemy [בטלמיוס] is found to be [?] from the west [?] —

Know that the lower half [?] of the sphere is likewise divided into seven climes [ז' אקלימי'], and it will be [?] on the pattern of what we have written concerning the [northern [?]] half — [?] the upper, and there is no difference between them, except that when in [?] the half above, it will be the beginning

of [?] under the sun; so that if at that same moment it is the end of the setting [?] of the sun in a locality in the [?] half of the sphere, the lower [?], which corresponds [?] [to it], [then] by the measure of the longitude [?] and the latitude [it is ...].

And do not be surprised at what we said, that in the [northern [?]] lower half of the sphere there is habitation [?] and seven [?] climes. For the [?] is that the sphere of the earth is the ultimate [?] [?], and the spheres that revolve around it are [?] — [?] the spirituality of the spheres [?] — [?] the earth [?] — [?] and it is suspended in the middle of the spheres, and in the middle [?] [?] from the sun; and by this [?] the reason [?] [that] the spheres [?] in the world [?] — and not in a single motion. And so [?] the earth [?] [?] the point of [?] [?]; it hangs in the air. And just so are the [?] material bodies [?] of the spheres [?], like this sphere of the earth: they too —

[Margin: outer (left) margin, on the line of the running header — the folio numeral "ד" (= 4), in the scribe's own display hand and ink. Above it, in the head margin at the extreme outer corner, a modern pencil 4. Standing lower in the same margin, two pale grey marks — a hooked stroke and a broken ring — of the kind recorded on ff. 1–3: pale, in the substance of the paper rather than on its surface, and showing at the mirrored position on the other side of this leaf.]

— [?] from the spirituality of the spheres [מרוחניות הגלגל]. They therefore all stand [?] upon the sphere of the earth with their heads upward [וראשיהם למעלה], toward the spheres. And so too the people who dwell in the lower half [בחצי התחתון] [?] of the sphere: they all stand upon the ground with their heads toward the spheres. So they are all found to be aligned [מכוונים] [?] over against all who dwell in the [?] half of the sphere — [?] on every side [?], and they are divided [?], for [?] the upper [?] [?] toward the sphere, upward, like those who dwell at the extremities [קצוות], who sit in the upper half [?].

So we and [?] are found to be above with respect to this [?], for always [?] the sphere of the earth, and the people over against the spheres; and just so for us who dwell [?] — [?] so for those who dwell above [?] — like those who dwell at the extremities [?]. There is in it no "above" [?]. It is found that every side [?] [?], and likewise "above" is above [?] [?] its own extremity [?]. ::

Chapter 2 [פרק ב" — in gold display letters]

On the exposition of the spheres that encompass the sphere of the ear[th] [בביאור] [הגלגלים המקיפים את הכדור] [הארץ] — [?] they are all [numeral: ?] spheres.

[?] one above the other [?]. The uppermost of all the spheres is the one called [?] the diurnal sphere [גלגל היומי], or the encompassing sphere [גלגל המקיף]. Beneath it, the stars of the constellations [כוכבי המזלות]. Beneath that, the sphere of Sha[btai — Saturn]; beneath that, the sphere of Tzedek [Jupiter]; beneath that, the sphere of Ma'adim [Mars]; beneath that, the sphere of Chamah [the

Sun]; beneath that, the sphere of Nogah [Venus]; beneath that, the sphere of Kochav [Mercury]; and beneath that, the sphere of the Moon [גלגל הלבנה].

Beneath it are the four elements [ד' יסודות], which are [?] from above downward [?] toward the [center?] [?]; and they are simple elements, not compound [והם יסודות פשוטים ולא מורכבים]. For beneath [?] the sphere of the moon there is the sphere of the element fire [יסוד האש], which is the highest, and the sphere of [the element] air [הרוח]; and beneath that [?] the sphere of the earth [?] [?]. Some of its parts are water [?] and seas, and some parts are dry land; and the parts of the dry land are sunk within the parts [?] of the seas, and the parts of the seas within the parts of the dry land. So it is found that the sphere of the earth is a point and the middle center [נקודה ומרכז האמצעי] of all the spheres that are compounded upon it, all of them.

[?] there is yet, above these spheres, the sphere of [?] — [?] the sphere of the Intellect [גלגל השכל], for it is not a body at all [אינינו גשם כלל] as the other spheres are [?] — [?] the uppermost [?] which is above it and encompasses them all [?].

[The following stretch — the comparison of the "body" of the spheres with the body of the four elements — is not recovered; see the QA note below.] [?] they are like a body [גשם], and [?] [?] the body of the spheres [?] [?] the four spheres of the simple elements [?]. And the body of the four elements is spiritual [רוחני] [?] the separate [intelligences?] [הנבדלים], which are compounded [?] [?], and [?] of the four elements [?] like the sphere of the earth, in sea and in dry land.

Know [ודע — written enlarged] that the uppermost sphere, which is [called?] the diurnal sphere, has no star in it at all [אין בו שום כוכב]. [?] therefore [?] the sphere [?] [?] — [?] and all [?] [?] [?] to carry [?] and to [?] them, [?] the spheres that [?], as is mentioned in chapter [numeral: ?] [בפ' ?].

And all the stars, all of them — [?] which revolve [?] from the east [?] to the [west?] [?] once in every 24 hours [פעם א' בכל כ"ד שעות] [?] — [?] constellations. The seven planets [ז' כוכבי לכת] are fixed in the sphere [?] which is called the sphere of the [constellations?]; and in the other [numeral: ?] spheres they are fixed [?]. In each one of them there is [?] but a single star [?] in each sphere of them [?], and these are the ones called the seven planets [?] [?].

[?] as [?] within [?] [?].

And let us return [ונחזור — written enlarged] to the matter of the spheres [?] [?] — [?] their [?] [?]. Know that [?] [?] the star [?] in the sphere [?], as [?] in the sphere [?], and the sphere is one, and the fixed star [?] —

[Margin: outer (right) margin — no folio numeral, as expected on a verso. The two pale grey watermark marks stand here at the position mirroring the recto's. Alongside the second band of text, at the height of the line beginning קו האופק והם קו האופק, there is a small brown mark in the right margin, three or four strokes wide, which may be two or three letters of a marginal word or may be an offset stain; I could not resolve it either way at this magnification and make no claim that it is a gloss. Nothing else stands in this margin. Faint

bluish-grey patches lower in the same margin are show-through from the recto.]

Now, each of these spheres has [?], after the manner of the two [sides/pivots?] [ב' צדדים] that the door of a doorway has: when upon the [?] the door turns [?] and swings back on its sides, so each sphere has two [sides/pivots] on which the sphere rests [שעליהם נשען הגלגל] and [?] turns. And those [?] about all the spheres [?] the air [?]; so [too] south and north. Hence there is one that [?] from the depth [?] upward, and there are among them [some that go] from above down[ward] [?] [?]. And therefore every sphere has two [sides/pivots], the one on the side and the second on the [south?] side; and upon them is a pole [קוטב] [?], and it swings back over against [?]. And so [?].

Now by way of illustration: just as [?] three lines that cut the sphere of the earth — namely the horizon line [קו האופק], the equinoctial line [קו השווה], and the meridian [קו חצי היום] — so they are in each and every sphere; and [?] such is the diurnal sphere. For so it holds good [כי כן יצדק] [?] three [?]: eight [?] lines [שמנת קוים] [?], or as [?] [?] one [?] like the sphere of the earth.

[?] to say that on the north side and the [?] [?] a general rule [?]. And the two sides of the diurnal sphere are the ones called a pole [קוטב] [?] like the horizon line [?]; [?] its [?] at the middle [?] in the place where [?]; [?] and the meridian passes through it [?], cutting the point [?] [?]; and over against it the [second?] pole [קטב] [?] over against [?] the [inner?] line [?] — the meridian, at the southern horizon line [?]; and two sides, or points [?].

In the science of astronomy [בהכמת התכונה] [there are] two poles [שני קטבים], [?] a northern [?], a southern point [?]; and the equinoctial line that is in the diurnal sphere is called [?] the middle of the breadth of the poles [אמצע רוחב הקטבים]. For as [?] the measure of its distance [?] from the [?] southern [?] line, so is the measure of its distance from the pole.

Know, further, that the stars [?] — [?] all of them [?] fixed and set [?], as [?] — [?] on the equinoctial line that is in the sphere of the constellations [בקר השווה שבגלגל המזלות], and [?] that a fixed star will be [?] at the mid-point of its own sphere [?], set [?] above, or the reverse [?]; [?] of all the stars [?].

The stars that are in the sphere of the constellations are divided into [numeral: ?] [?]. [?] the stars that are found in the twelve figures [ב"ב צורות] [?] which are called constellations; and the rest of them are fixed on the equinoctial line, [running] round about it [?] — [?] in the whole sphere [?], and the other stars [?] [?].

[The following stretch is not a witness; see the QA note.] [?] as [?] [?] [?]. And [?] [?] the new [?] [?] above, they are [?] of the twelve constellations that are in the sphere [מן הי"ב מזלות שבגלגל]; they are [?], or [?] in one place [?] — also [?] the beginning [?] stars [?] [?] the beginning of the motion [?], as in the place of the twelve [?].

Each and every sphere has one point [נקר' א'] called [?] — [?] its sides [?] [?] motion [?] and its longitude [?] [?] — [?] center [מרכז]; and there are those who call it a "degree" [מעלה].

Know, further, that each one of these spheres, small or great, is divided into [?] degrees, and into minutes [חלקים], and into seconds [שניות], and so on, just as [?] [?]. So likewise [?] the sphere of [?] four quarters [ד' רביעים] and [numeral: ?] parts [חלקים], and there [?] degrees [?] of the constellations [?]; and here [?] are [?], and the sphere [?] — and it is divided [?], and by the measure of [?] [?]

[?] all the spheres: for they are not equal [שאינן שוין] in the matter of their centers [?] [מרכזיהם] and their points [ונקודתיהם] and their [poles?] [?]; [?] [?] the [?] portion [?] of one sphere of them alone, that is to say [?], and forever [?]

[Margin: outer (left) margin, on the line of the running header — the folio numeral ה (= 5), a single display letter in the scribe's own hand and ink, standing clear of the text block. In the head margin at the extreme outer corner, a modern pencil 5. Lower in the same margin, two pale grey marks — a hooked stroke and a broken ring — the watermark already recorded on the earlier leaves, in the substance of the paper rather than on it.]

[Margin: outer (left) margin, alongside the twelfth to fourteenth body lines — a gloss of three short lines in a hand markedly smaller, thinner and more rapid than the scribe's, in a greyer brown. I could not read it and I make no claim about its content; individual letters resolve but no word does. It is certainly ink and not a stain: the mirrored position on the other side of this leaf carries it as a faint bluish show-through. What it attaches to in the main text I also cannot say — the body lines it stands beside are among the weakest on this side. See the QA note; a separate finer cut is requested.]

— [?] the rest of the lower spheres [שאר הגלגלים התחתונים], though they are all bound together [עם היות שכלם קשורנים יחד] [?] — [?] each of them having two poles [ב' קוטבים] [?]. And they are joined [?]; even so, there are among them many differences [יש בהם שינויים רבים] [?].

[?] the differences that are in them; and through this we can know [נוכל לדעת] the time of [?] [?], and to know the molados and the tekufos [לדעת המולדות והתקופות], and the eclipses [הלקיות], and the judgments of the stars [משפטי הככבים], and the changes that occur [התמורות הקורות] [?] — [?] [?] by way of [?] the stars [?].

[?] this against that [?] the matter of the differences; and these are the five differences [והנה ה' שינויים הם] [?]. The first difference [השינוי הא'] concerns the centre [במענין המרכזים] [?]. It is this: it would have been fitting that the centre of the sphere of the earth itself should be the centre of each and every sphere [שמרכזו כדור הארץ עצמו יהיה הווא המרכזו שלכל גלגל וגלגל] [?] — [?] that the earth [?] [?]. But it is not so [לא כן היה], for there are among them a sphere whose centre is the centre of the sphere of the earth itself [שמרכזו הוא מרכזו כדור הארץ עצמו], and there are those whose centre goes out and is distanced from the centre of the sphere of the earth [ויש שמרכזם יוצא ונתרחק מן מרכזו כדור] — [?] for the sphere itself, too, is distanced further toward one side than [?], and therefore [?] from the stars [?] it is distanced, and it goes out from the centre of the sphere of the earth [ויוצא ממרכזו כדור הארץ].

This sphere, then, which is distanced [?] toward one side more than toward the other, is likewise called an eccentric sphere [גלגל יוצא מרכז], since its centre goes out from the place of the centre of the sphere of the earth [מרכזו]. And not all the eccentric spheres [הגלגלים היוצאים מרכז] are equal in the measure [?].

[The following line is not a witness — see the QA note.] [?] the centres [?], for there is an eccentric [?] such a measure [?] [?] the lower [?] [?] all the spheres [?].

[?] the eccentrics [היוצאים מרכז], for all their [?] is toward the [?] side; and see chapter [numeral: ?] [?] [בפ"] — [?] the eccentric sphere of Shabsai [Saturn] [גלגל היוצא מרכזו של שבתאי] [?].

The second difference [השינוי הב'] concerns the two poles and the horizon line [ב' הקוטבים וקו האופק]: for there are [spheres] whose poles are [?] the poles of the earth exactly [קוטבי הארץ ממש], and there are those whose poles are displaced from the poles of the earth [מקוטבי הארץ] — [ויש שקוטביו] — for its northern pole stands high, above the pole of the earth [למעלה מקוטב הארץ], and, over against it, its southern pole descends below the southern pole of the earth [קוטב הדרומי]. And by the measure of the elevation of its northern pole [שיעור גובה קוטב הצפוני] above the northern pole of the earth, so is the measure of the depression of its southern pole [שיעור שפלות קוטב הדרומי] beneath the southern pole of the earth. There will be a difference likewise in [?] their equinoctial line [קו השווה שלהם]; and this difference follows from the difference of [?] — [?] the second, for so the equinoctial line is as the middle [קו השווה הוא כאמצע] of the sphere itself. So too the horizon, and the two poles, are distanced from the equinoctial line [?] [?] — [?] [?] in a complete difference [בשינוי גמור] [?]. [?] likewise, for according to the measure of the elevation of the northern pole of the sphere [גובה קוטב צפון של הגלגל] above the pole of the sphere of the earth, so will be the measure of the distance of its equinoctial line toward the south from the equinoctial line of the earth [קו השווה] [בחצי כדור העליון], in the upper half of the globe [שלו לצד דרום מן קו השווה של הארץ]; and over against this, in the lower half of the globe [בחצי כדור התחתון] will be the measure of the inclination [שיעור נטיית] of the equinoctial line which is above there in the sphere, distant and drawn toward the north [?], from the equinoctial line of the sphere of the earth.

The third difference [השינוי הג']: for there is a sphere that is [?] from beneath upward, and there are [some] [?] turned from above downward [מוסבב ממעלה למטה].

The [fourth?] difference [השינוי הד'] is by the measure of the lag of their course [כשיעור איחור מהלכם], for there is [one] turned [?] and there is [one] [?] [?].

[The two closing lines are half recovered; see the QA note.] Now these five differences [והנה ה' שינויים אלו] [?] [?] are bound to be completed together [?] in one sphere [?] — [?] the differences named above [השינויים הנז'], which are the second and the third, since they depend upon [?] [?] this against that,

as stated. For whatever has its poles differing and inclined above the poles of the earth [מי שקוטביו משונים ונוטים מעל [קוטבין] הארץ], it necessarily follows that its [equinoctial] line too [השוה] קו [השוה] —

[Margin: outer (right) margin — no folio numeral, as expected on a verso. The two pale grey watermark marks stand here at the position mirroring the recto's. Lower in the same margin, alongside the fifth to eighth body lines, a faint bluish-grey patch of small strokes: this is show-through of the marginal gloss on the other side of this leaf, not writing on this side, and I have transcribed none of it. Nothing else stands in this margin.]

— the equinoctial line of that sphere will be inclined away from the equinoctial line of the earth [השוה שלו יהיה נוטה מקו השוה של הארץ].

Now consider a sphere whose centre is the centre of the earth itself, but whose poles and equinoctial line are inclined away from the poles and the equinoctial line of the earth [מי שמרכזו הוא מרכז הארץ עצמו אלא שקוטביו] [וקו השוה שלו נוטים מקוטבי וקו השוה של הארץ]: this is called an inclined sphere [כי הוא נוטה לצדדים], but it is not eccentric [אבל אינו יוצא מרכז]. And that whose equinoctial line and poles are aligned with the equinoctial line and the poles of the earth [מכוונים בקו] [אלא], but whose centre goes out from the centre of the earth [השוה וקוטביו הארץ], is called an eccentric sphere [זה נק' גלגל יוצא מרכז], and it is not called inclined [ואיננו נק' נוטה]. And there is a sphere that is eccentric and is also inclined in its poles and in its [?] lines [יש גלגל שהוא יוצא מרכז וגם] [הוא נוטה בקוטביו ובקויו] שלו, and it is called [both] as well.

[?] such as the diurnal sphere [כמו גלגל היומי]; and see chapter [numeral: ?] [?] — [?] [?] this matter.

There is yet a [sixth?] difference [עוד יש שינוי ש] concerning the spheres, and it is this: the two uppermost spheres — the diurnal sphere and the sphere of the constellations [ב' הגלגלים העליון] שהם גלגל היומי וגלגל המזלות — each of them is called one sphere only [כ"א מ] [הם] אינו נק' רק גלגל א' בלבד]; whereas all the lower spheres [אבל כל הגלגלים התחתונים] — each sphere of them is divided into several spheres [כל גלגל מהם נחלק לכמה גלגלים], and all of them are called the sphere of [?] [?] [?] [?].

Know, further, that all the great spheres named above [כל הגלגלים הגדולים כנו], and likewise all the lower spheres [וכן כל הגלגלים התחתונים] — every sphere [?] — are spheres that encompass and revolve about the whole world [הם] [גלגלים מקיפים וסובבים העולם כולו] [ובתוכם עומד כדור הארץ כולו]. But there are among them small spheres [אבל יש מהן גלגלים קטנים] [?] — [?] the lower spheres, and likewise the sphere of the epicycle [גלגל ההקפה]. These do not encompass the sphere of the earth [ואינם מקיפים את כדור הארץ], and the sphere of the earth is not at their middle, nor within them below, at all [ואין כדור הארץ באמצעם ובתוכם למטה כלל].

[?] the measure of the sphere is small [?]. The one called the epicycle revolves about the earth, and yet the earth is not inside it [הנק' גלגל ההקפה סובב סביב הארץ] [ואין כדור הארץ בתוכו]. The character of this sphere is that [?] it is a very small sphere

[גלגל קטן מאד], the measure of the whole circumference of its circle being as the measure of the thickness of the sphere in which [שיעור (?) כל היקף עיגולו]; and [ומוסבב וקבוע בו] it is [?], turned and fixed within it [כשיעור עובי הגלגל אשר בקו השווה של ?] is on the equinoctial line of its own great sphere [גלגל הגדול שלו], called the [?] sphere, in which it is turned. Being fixed there within the thickness of the breadth of the sphere [בעובי רוחב הגלגל], it rolls there from the underside of it to the upper side of it [הוא מתגלגל שם ממתחת שבו למעלה], or the reverse [או להפך]. It has two poles of its own, driven [?] into the thickness of the wall of the great sphere [בעובי דופן הגלגל הגדול] on its northern and on its southern side [מצד צפוני ודרומי]; and it likewise has an equinoctial line, exactly [יש לו ג"כ קו השווה ממש] [?] set opposite the equinoctial line of its great sphere [מכוון כנגד קו השווה של הגלגל הגדול שלו]; and the star [והכוכב] — [?] [?] the sphere called [?], fixed there, as [?] [?] — the equinoctial line of the epicycle [קו השווה של גלגל ההקפה].

So it emerges that the epicycle has two revolutions [ב' סיבובים]. The first is that [?] is turned, its whole self, about the earth [שמוסבב כל עצמו סביב הארץ] [?], and is called [?] — by the revolution of its great sphere [ע"י סיבוב גלגלו הגדול] [?]; its motion is found, and it turns the epicycle along with it [ומסבב גם את גלגל ההקפה]. The second is the revolution of the epicycle's own self [?] [הסיבוב עצמו שלו] [?], as [will be shown] below [כדלקמן]; and on its arriving [?] at its place within the wall, in the thickness of the eccentric great sphere [תוך דופן עובי הגלגל הגדול] [?], and above, there is [?].

[?] a difference between the [?] of the motion of the epicycle [שינוי בין ?] [ההקפה לשאר הגלגלים] [?] the epicycles of the rest of the spheres [תנועת גלגל ההקפה]; and it is like [?] the epicycle that they have — the planets [ככבי לכת], which are [numeral: ? — obscured by an ink blot] below [?] — they are turned [?], turned toward the side of the revolution of their own great sphere [מוסבבים לצד] [?], for [?].

The great sphere of Shabsai [Saturn] [?] [גלגל הגדול של שבתאי] [?], the one called the eccentric sphere [הנק' גלגל היוצא]: its eccentric is turned from below upward [והגלגל ההקפה שלו] [היוצא שלו מוסבב ממתח למעלה], and its epicycle too [מוסבב ממתחת למעלה]; and so with all the spheres above — except in the sphere of the Moon [זולתי בגלגל הלבנה], for it alone [כי הוא לבדו]: its great sphere, its eccentric, is turned toward the [?] side [?] [היוצא שלו מוסבב לצד], while its epicycle is turned the opposite way from it, toward the other side [מוסבב להפך ממנו ולצד האחר] [?], as will be explained below [כמו שיתבאר לקמן].

[?] as in chapter [numeral: ?] [כפ"ו]. And so the seven planets [ז' ככבי לכת] have epicycles [יש להם גלגל?] [ההקפה] — all but the sphere of Chamah [the Sun], which has no epicycle [חוצ' מגלגל חמ"ה שאין לו גלגל ההקפה].

[Margin: outer (left) margin, on the line of the running header — the folio numeral 6 (= 6), a single display letter in the scribe's own ink, standing clear of the text block toward the outer end of the head margin. At the extreme outer corner of the head margin, a modern pencil 6. Lower in the same margin, two

pale grey marks — a hooked stroke and a broken ring — the watermark already recorded on the earlier leaves, in the substance of the paper rather than on it. No marginal gloss stands on this side; the outer margin stands empty from the text block outward to the fore-edge.]

— However, [?] the Sun itself is fixed [תקועה] [?] in the great sphere. There is yet another difference [עוד יש שינוי אחר]: the great sphere [?] has a measure and a time of its own for the revolution of its course [יש לו שיעור וזמן לסיבוב מהלכו], while the sphere of the epicycle has another measure and time [וגלגל ההקפה יש] [ל] for its own revolution and its own course [לסיבובו ומהלכו]; and the time of their revolutions is not the same [ואין זמן סיבובם שוה].

And know [ודע] that the measure of the course [שיעור מהלך] [?] and it is divided into [numeral: ?] degrees [ומתחלק ל?] [מעלות] [?].

[?] [?] [?].

[?] like this [כזה]. And all the matters that [?] in this epicycle within the sphere [וכל העניינים ש?] בזה ההקפה בגלגל] will each be explained in its place [יתבאר כל א' במקומו]. We shall now set out the matter [ענין] of the lower spheres [הגלגלים התחתונים], such as the sphere of [?] [?], except the sphere of the epicycle [זולתי גלגל ההקפה].

And know that the rest of the lower spheres [הגלגלים התחתונים] of [?] are divided into several spheres [מתחלקים לכמה גלגלים], and they are [?] spheres — three great spheres that encompass the world [ג' גלגלים גדולים מקיפים] [?] and also small spheres that do not encompass the whole world [וגם] [גלגלים קטנים שאינם מקיפים כל העולם] and likewise the sphere of the epicycle [וכן גלגל ההקפה] great spheres.

They divide into three kinds [נחלקים לג' מינים]. The first kind [המין הא'] is the domeh sphere — the resembling sphere [גלגל הדומה] — that is to say [ר"ל], one that resembles [שדומה] [?] in all respects [בכל] [העניינים] another sphere [?] the sphere of the constellations [גלגל המזלות], since it resembles it [כי הוא דומה] [?] — whether in [?] its motion [תנועתו] [?] below, or in the measure of its course [הן כשיעור מהלכו], or [?] — in its course [במהלכו]; and because, just as the sphere of the constellations has its course [?] [וכי כמו שגלגל] [?] the earth [הארץ], so it is necessary in the sphere [?] that resembles [?] [הדומה] [?] its poles too, and its equinoctial line, are like the poles and the equinoctial line of the sphere of the constellations [גם קוטביו וקו השווה שלו הם כקוטבי וקו השווה של גלגל המזלות] equal [?] in itself, and they are set together one against the other [ומכוונים יחד זה כנגד זה].

However [אמנם], the poles and the equinoctial line of the sphere of the constellations and of the sphere [גלגל המזלות ושל גלגל] are not like the poles and the equinoctial line of the sphere of the earth [אינם] [כמו שיתבאר] [לקמן], as will be explained below [כקוטבי וקו השווה של כדור הארץ].

And there is a domeh sphere [ויש גלגל הדומה] in the revolution [בהקפת] [?]; and here [?] of the sphere of the constellations, by the measure of its course and according to the manner of its motion [כשיעור מהלכו וכפי דרך תנועתו] [?] [?]

below, and therefore it is called by another name [ולכן נק' לו שם אחר]. And so there is a sphere of irregular course [והנה גלגל משונה המהלך] [?] [?].

[?] Nogah [Venus] [נוגה]. · And there is a domeh sphere in all the [?] except [?] its motion, which is [?] above. · [?] [?] is done in the sphere of the Moon [בגלגל הלבנה], and it is called the course of the sphere [ינק' מהלך גלגל] [?] [?] [?] it emerges that this sphere [נמצא שזה הגלגל] [?] [?] is sometimes called a sphere of irregular course [ינק' לפעמים גלגל משונה המהלך]; and it is called [?] of the Sun or of that star [השמש או הככב ההוא], and it is called [?].

The [numeral: ?] kind [המין ה'בג'ז'] is called the inclined sphere [וכבר נתבאר] ענינו למעלה [נק' גלגל הנוטה], and its matter has already been explained above. The [numeral: ?] kind [המין ה'בג'ז'] is called the eccentric sphere [גם נק' גלגל הנושא], It is also called the carrying sphere [נק' גלגל היוצא], since it carries the sphere of the epicycle within its thickness [כי הוא נושא את גלגל ההקפה בעוביו].

[?] the lower ones — the spheres of the epicycle: these are one kind only [?] [ינק] [?] שמות [?], and they are called by [?] names [גלגלי ההקפה מין א' הם בלבד] [?] [?] [?] another [?] or a sphere , [?] the epicycle, or the sphere of the [?] [ההקפה או גלגל הם], since the star is fixed in it [יען כי בו תקוע הכוכב], like [?] the constellations, or it is called [?] [?] [?]. .

[Illegible: an enlarged display word opens the paragraph here — four letters, the last a final mem] — they are alike in these respects [שׁוּיִם בְּעֵינֵינִים], since each one of them [יֵשׁ לוֹ ב' גִּלְגָּלִים גְּדוּלִים] has two great spheres [כִּי כָל א' מֵהֶם] which are the [?] and the eccentric [שֶׁהֵם ה[?] וְהַיּוֹצֵא]; and it also has one small sphere, that of the epicycle [גַּם יֵשׁ לוֹ גִּלְגָּל א' קָטָן שֶׁל הַהֶקְפָּה], and all [?] spheres, or the great ones [?], and the sphere of the epicycle is called one sphere [וְגִלְגָּל הַהֶקְפָּה נִקְ' גִּלְגָּל א'] — whether of Shabsai [Saturn] [שַׁבְּתַי], or of Tzedek [Jupiter] [צֶדֶק], or Ma'adim [Mars] [מֵאֲדִיִּם]. And Chamah [the Sun] [חַמָּה] has two great spheres, the domeh and the eccentric [יֵשׁ לוֹ ב' גִּלְגָּלִים גְּדוּלִים הַדּוּמָה] [וְהַיּוֹצֵא], and it has no sphere of the epicycle [וְאֵין לוֹ גִּלְגָּל הַהֶקְפָּה]. · And Nogah [Venus] has three great spheres [וְנוֹגָה יֵשׁ לוֹ ג' גִּלְגָּלִים גְּדוּלִים] — the domeh and the eccentric [הַדּוּמָה וְהַיּוֹצֵא], and also small spheres [וְגַם גִּלְגָּלִים קְטָנִים] [?] of the epicycle, this one turned [?] [וְזֶה מְסוּבָּב]; and the whole motion [וְכָל הַתְנוּעָה] is called one sphere [נִקְ' גִּלְגָּל א']

[Margin: outer (right) margin — no folio numeral, as expected on a verso. The two pale grey watermark marks stand here at the position mirroring the recto's — out in the body of the outer margin, clear of the text block. Nothing else stands in this margin, and there is no gloss on this side. The text block on this side sits markedly further from the fore-edge than on the recto — its right edge falls appreciably short of where the recto's stands — so the whole measure is shifted toward the gutter, which on a verso is the left.]

— of Nogah [Venus]. And Kochav [Mercury] has three great spheres [וככב יש לו ג' גלגלים גדולים] — the eccentric, the domeh, and the carrying sphere [היוצא והדומה והנושא] — and three small spheres of the epicycle [וג' גלגלים קטנים של ההקפה]; and all of

them together are called one sphere, that of Kochav [של ככב] — the domeh, the eccentric, and the inclined [הדומה והיוצא והנוטה] — and one small sphere, that of the epicycle [וגלגל א' קטן של ההקפה]; and all of them are called one sphere, that of the Moon [של לבנה].

And the whole [?] [?] [?], for they are seven [numeral: ז' / ו'] great spheres [כי ז' גלגלים גדולים הם] — three of the Moon and three of Kochav [ג' של לבנה וג' של ככב], and two for the sphere [ושנים לגלגל] of the [?] stars [?], the lower ones [התחתונים] [?]; and three small spheres of the epicycle [וג' גלגלים קטנים של הקפה] — two for Nogah and two for Kochav [ב' לנוגה וב' לככב], and [?] for Chamah [the Sun] [?] the stars [?]. But Chamah has no sphere of the epicycle at all [אבל לחמה אין לה שום גלגל הקפה]. And see chapter [numeral: ?] [פ"א].

פרק ג'

[The chapter rubric is written in gold — פרק in full, followed by a single gold numeral letter with gershayim — standing at the head of its line, with the chapter's opening words continuing on the same line to its left. Gold is the only colour used for decoration on this leaf; the red at head and foot is the border rule.]

[?] the great sphere [?] [הגלגל הגל] the uppermost are three [הנק' גלגל היומי], which are called: the diurnal sphere [הגלגל היקף]; and it is likewise called [ג"כ נק'] the sphere [?] — the portion [החלק], since there is in it [?] no star at all [עין אין בו]. [שום כוכב כלל]. [?] the stars [?] all the spheres that we have written of [את כל הגלגלים שכתבנו] in it, of the motion; and the motion is in one whole day of twenty-four hours [התנועה כיום א' שלם של כ"ד שעות], and therefore it is called the diurnal sphere [ולכן נק' גלגל היומי].

And if we should say that there are spheres [ואם נאמר שיש גלגלים] whose motions are contrary to the motion [שהתנועות הפכיות מן התנועה] always — and also because [?] the time of the revolution of the motion of their course [זמן סיבוב תנועת מהלכם] would be [?] [?], and a long time [זמן ארוך] [?], so that the sphere [היה גדול מכלם] [?] would be the greatest of them all [וזה כי הוא מקיף] alone, and all of them are set [?] [?], therefore there is in it [?] [?].

[?] and to the stars [?] its motion is the reverse of the motion of their revolution [תנועתו הפך תנועת סיבובם] — the stars, even though they move [?] in one day only [כיום א' בלבד], and even so [ועכ"ז] [?] the motions [?] [?] are set in order [מתוקנים]. And this revolution does not annul their first revolution below [ואין סיבוב זה מבטל סיבובם הא' למטה]; this resembles [זה דומה] a revolution [?] [?] small [?] within one great sphere [בגלגל א' גדול], while the star [והככב] [?] and travels gently [ומהלך בנחת] at the time of [?] [?] the sphere of the constellations and its centre [הגלגל מזלות ומרכזו] [?].

[?] the sphere moves downward [הגלגל מתנועע למטה] [?] [?] and it turns the sphere that moves upward [ומסבבת הגלגל מתנועע למעלה], like this one, which has no [?] [?] a small revolution [סיבוב קטן] [?] another; the sphere is turned [?] [?], or the sphere within the sphere [הגלגל בגלגל] — all its particulars [כל פרטיה] [?] [?] that it turns the sphere, which moves [?] upward [?]; and it is likewise found turning and moving downward [מסבבת ומתנועע למטה]. And there is [?] [?] it moves downward in its own way [הוא בדרכה מתנועע למטה], and if it itself is reversed [ואם הוא עצמו מתהפך] [?] [?] and all the revolutions are performed in one time [וכל הסיבובים נעשים בזמן א']. And also, as with the matter of the union [עכ"ז מתנועעת] [?] great [?] and a waiting [?]; even so it moves [?] [?] over against one [?] which turns the sphere with the swiftness of [?] [?] [המסבבת את הגלגל כמהירות] [?].

And so it is with the spheres [וכן הענין בגלגלים], for there are among them [?] that move and turn from above downward [מתנועעים ומסבבים מן המעלה למטה]; and with [?] [?] great [?], and in this time [?] itself, which turns the diurnal sphere [מסבבת בהיקף] [?] a revolution [?] moving upward [מתנועת למעלה], and also that it [?] — it is of great swiftness, twenty-four hours only [הוא כמהירות גדול כ"ד שעות בלבד] [?] and it cannot [?] [?] its revolution [?] [?] their revolution [?] in themselves, in its own way [בעצמם בדרכה].

Now as to the matter of the division of the time of its revolution [ואמנם ענין] [?] [הנה כמה שעות] [?] — see how many hours [ההתחלקות זמן סיבובו] [?] of a whole day, divided into twenty-four hours [של יום] [אשר בענינו]. [?] and it is divided into the twelve constellations [שלם מתחלק לכ"ד שעות] [?]; [?] [נחלק לי"ב מזלות], and therefore the diurnal sphere [ולכן גלגל היומי] [?] [?] the portion is divided into twelve great parts [החלק נחלק לי"ב חלקים גדולים] [?] and the measure of the time of the revolution of each

[Margin: outer (left) margin. On the line of the running header, standing alone toward the outer end of the head margin, a single display letter in the scribe's own ink, which I read as ז (= 7) — the folio numeral. Lower in the same margin, the pale grey hooked strokes already recorded on the earlier leaves, in the substance of the paper. A marginal gloss stands in this margin, running alongside roughly body lines LI–LII; only its innermost letters reach into the region I could read, and the whole of its body lies outside that region, further out toward the fore-edge. I have not attempted it.]

— each of them is called one great hour [חלק מהם נק' שעה א' גדולה]. It emerges, then, that the revolution of all twelve parts of the diurnal sphere is as the measure [ונמצא כי סיבוב כל י"ב חלקי הגלגל היומי הוא כשיעור] [?] of twelve great hours, whose time is called one whole day [י"ב שעות גדולות אשר זמנם נק' יום א' שלם]; and the primary sense of "hour" is this great hour, as mentioned [ועיקר שעה הוא שעה זו] [הגדולה כנ'] [?].

[?] [?] and so it is divided [וככה יתחלק] [?] the small [הקטן] [?] [?] [?] astronomy [התכונה] [?] [?] the sages [חכמים] [?].

And they divided this great hour into [numeral: ?] small hours [ונחלקו שעה], so that the measure of one day and its night comes to twelve great hours [ונמצא שיעור יום א' ולילו הם י"ב שעות גדולות], which are twenty-four small ones [שהם כ"ד קטנות]. And wherever "hour" is said without qualification [הוא השעה קטנה], the small hour is meant [ובכל מקום שנא' שעה סתם], except where [?] is specified [([?]) זולתי כשמפורש].

[?] a great hour. · Moreover, the sages divided [?] this one, and the small hour into [?] [?] they are. [?] one whole day, its night and its day, into [numeral: ?] parts [?] [?] א' שלם לילו ויומו ל[?], and they are called [?] minutes [דקים]. · Further, they divided [?] [וכל מעלה ממעלות הגלגל] each degree of the degrees of the sphere [עוד שחלקו] into [numeral: ?] parts [?] and it emerges that the hour is [numeral: ?] minutes [?] [תתר"ף חלקים] 1080 parts [?] [ונמצא שהשעה היא ? דקים]. And [the reason for] [?] their being divided by this number [התחלקם למספר זה] is that this reckoning of 1080 parts [?] [הוא לפי שיש בזה החשבון של תתר"ף חלקי] the hour [?] — a half [?] [ח[צ/ל]], a quarter [?] [רביעי], an eighth [?] [ושמונית], a third [?] [ושלש], a ninth [?] [וש[ת/ת]], a fifth and a tenth [?] [ויכול להתחלק לחמשה]; and it can be divided into five [?] parts.

And it emerges that this diurnal sphere completes one whole revolution in one whole day together with its night [ונמצא כי זה הגלגל היומי מסבב סיבוב א']; and, running from the point of the eastern horizon line [וליהיות מנק' קו האופק המזרחי], it revolves to the point of the western horizon line [סובב לנק' קו האופק המערבי] of the day [היום], and from there returns to a fresh revolution [ווחזור משם לסיבוב חדש]. [?] the lower [התחתון] as far as the point of the eastern horizon [האופק המזרחי] the sphere [?]. And there is no difference between one day and the next [ואין שינוי בין יום זה לחבירו]; rather all the days [שעות], since on each and every day it completes a whole revolution [כי בכל יום ויום מסבב סיבוב שלם] the whole globe of the earth, and returns to its place [כל כדור הארץ וחזור למקומו] at the point of the eastern horizon every single morning [האופק המזרחי בכל בקר] [בנק']. And so [?] its motion of revolution [התנועה] [סיבוב] and it turns the whole sphere [ומסבב את כל הגלגל] [?] [?] and the motions [ותנועות] are made [?] [?] upward [למעלה] [?] a revolution [סיבוב] on each and every day [כל יום ויום], apart from its own motion [וזולת תנועתו] the composite [מתנוע[ע] למעלה כנו'] moving upward, as mentioned [המורכבת]. ·

And now that we have set out the horizon [האופק] [שביארנו], its motion and the measure of the time of its revolution [תנועתו ושיעור זמן סיבובו], we shall further set out [נבאר עוד] the rest [שאר] [?]; for the [?] and the poles [והקוטבים] [?] belonging to it, and the three lines belonging to it [ולג' הקוים אשר לו], which are the horizon line, the meridian line, and the equinoctial line [שהם קו האופק] [שבו כלם מכוונים ממש] [וקו חצי היום וקו השווה כנגד הקוים והקוטבים] their matter [?]. And every place [?] where we shall mention the matter of the centre of the world [מקום אשר נזכיר ענין מרכז]

[העולם] and the poles of the world [ויקוטבי העולם] and the three lines of the world [וג' קוים של העולם] — all of them are in this [כולם הם בזה] diurnal sphere, which is set exactly [הגלגל היומי אשר הוא מכוון ממש] on every side toward the globe of the earth [בכל פנים אל כדור הארץ]. This never varies in any place [זה ולא] the primary [?] — the three names of these lines [?] [?] in this diurnal sphere [הגלגל היומי], since in it lies the primary [ג' שמות הקוים האלה] and the name[s] [?]: [?] that [?] of the globe of the earth is called [השעה כנ"ל] the hour, as above [של כדור הארץ נק']; and since this is so [וכיון שהוא כן], we shall now set out [שנבאר עתה] the names [?] of the three lines [השמות [?] ג' קוים] [?].

[?] in this diurnal sphere [או שבגלגל זה היומי]: the [?] line [ההנהה הקו ה] [?] the sphere is divided [הגלגל נחלקין], and its motion [?], part of it upward and part of it downward [חלקו למעלה וחלקו למטה]. [?] is called the horizon [הוא נק' האופק], and [?] this line is [?] [הקו הזה הוא] [?] the time of the rising of the sun and the time of its setting [עת זריחת השמש ועת שקיעתה], and it is [והוא] [?]. For after it has become clear that this sphere revolves [כי אחר שנגלה] כי זה הגלגל מסבב [שאר הגלגלים שכתבנו] the rest of the spheres of which we have written [מתנועע] למעלה], moving upward [?]

[Margin: outer (right) margin — no folio numeral, as expected on a verso. The pale grey hooked strokes of the watermark stand here at the position mirroring the recto's — out in the body of the outer margin, clear of the text block. Nothing else stands in this margin, and there is no gloss on this side.]

It emerges that the sphere of the heavens [?] [נמצא כי גם גלגל השמי], although it moves [עם היותו] מתנועע] with a contrary motion [הפכיית], moves [?] [?]; here too it moves in the opposite direction from it [הנה גם הוא], so as to move in one whole day one complete revolution [מתנועע להפך ממנה], [להתנועע כיום א' שלם סיבוב א' גמור]. It will be seen, therefore, that although the days of the solar year are 365 days [ולכן יראה כי עם היות שימי שנת החמה הם שס"ה] [?] of [אשר הוא שיעור סיבוב] — which is the measure of the revolution [סיבוב א' שלם שלי] — nevertheless we see with our own eyes [עכ"ז] אנו רואים בעינינו] that on each and every day it completes one whole revolution [שכל יום ויום מסבב סיבוב שלם אחד] [?] the whole world [?] [?] sets [והוא כמנהג ולעולם] [?] [?] and returns as usual, and always [כי בכל פאה ובכל] [?], for on every side and in every [?] [שוקע] [?].

[?] the body of the sun [ככב השמש] passes the horizon line of the diurnal sphere [עבר קו האופק של הגלגל היומי] [?] the hour of the rising of the sun [שעת זריחת השמש]. [?] And when the sun inclines toward the western horizon line [וכשנוטה השמש אל קו האופק המערבי], [?] it is the line of the hour of its setting [הוא קו שעת שקיעתה]. [?] And the line called the meridian line [והקו הנק' קו חצי היום] — its use is to know the time of the rising of the sun and of its setting in every [?] [והקו הנק' קו השווה] [?], which vary according to [?] [המשתנים כפי ה] [?]. And the line called the equinoctial line [והקו הנק' קו השווה] — its use is to know the measure of the magnitude [והקו הנק' קו השווה] [?] of the day [?] the sphere; for this depends on the

entry [?] of [כי זה תלוי כפי כניסת] [?]. And the matter of this line [וענין זה הקו] [?] below, in chapter [numeral: ד'] [לקמן [ב/כ]פ"ד]. • And we shall set out [ונבאר] [?] this line called the meridian [הקו הזה הנק' חצי היום] [?] so it is, because [?] there the sun will be [שם [ה]שמש יהיה] [?]. [?] the meridian [חצי היום] [?]: for according to the measure that there is from the eastern horizon [כי כפי שיעור] [?] — as far as this meridian line [עד זה הקו של חצי היום] [?], so it is [שיש מן האופק המזרחי] [?] — the measure of the distance that runs from the meridian line to the western horizon [שיעור מרחק אשר מקו חצי היום לאופק מערבי] [?]. And it emerges that when the sun inclines toward the horizon [ונמצא כי כשנוטה השמש לאופק] [?], and when it inclines toward the meridian line, which is called midday [וכשנוט[ה]] [?]; and when the sun inclines toward the western horizon [וכשנוטה השמש לאופק המערבי] [?] it is called [?] the sphere [הגלגל] [?]; and when the sun inclines toward the meridian line [וכשנוטה השמש אל קו חצי היום] [?].

[?] the globe [?] the earth is half the sphere [הארץ הוא חצי הגלגל], and this is [?]; [?] and those who dwell [והשוכנים] [?] in the [?] half of the globe [העומדים] [?] those standing in the lower half of the globe [בחצי התחתון של הכדור] [?] as above [כנ"ל] [?] — for them everything there is the reverse of ours [הנה שם הכל היפך ממנו]. It is different [שהוא שונה]: the moment of our sunrise is the time of their setting [כי רגע הזריחה שלנו הוא עת השקיעה שלהם], and our setting is the time [?] of their rising [שקיעתה שלנו הוא עת]; and our midnight is their midday [וחצי הלילה שלנו הוא חצי היום שלהם], and our midday is their midnight [וחצי היום שלנו הוא חצי הלילה שלהם] — for in all things they are the reverse of us [כי הם בכל הדברים להיפך ממנו]. • And here [?] the time of rising and of setting, and midday and midnight [עת הזריחה והשקיעה וחצי היום וחצי הלילה] [?] were the earth [היתה הארץ] [?] as the measure [כמו שיעור] [?] of the earth [?] in [?] equal in time [שוה בזמן] [?] because it is [?] [לפי שהיא] [?] in all the [?] which [?] the part [החלק] [?] in the eastern horizon [באופק המזרחי] [?] it will not rise [לא יזרח] [?] like a globe, as above [ככדור כנ"ל]; and therefore, when the sun rises [לכן כאשר יזרח השמש] [?] but for the [?] which are far from the east and lie [אשר הרחוקות מן המזרח ושוכנות] [?] the lands that are near the eastern side [המדינות אשר הם קרובות אל צד המזרח] [?] so the [?] of the east to the [?] of the west [כן מעלות המזרח למעלות המערב] [?] in the west, since the globe of the earth is round [במערב כיון ש[?] כדור הארץ] [?] the rising of the sun is not seen there [שעה אחת] [?] evening [ערב] [?] one hour [אין ז[רי]חת השמש נראת שם] [?] in the lands near to the east [במדינות הקרובות אל המזרח]; and all the lands that stand further off from the eastern horizon [שיתרחקו מן האופק המזרחי] [?] — according to the measure of their distance [כפי שיעור ה[רחקם]] [?], so is the measure of the time by which the rising of the sun is delayed for them [כן שיעור זמן איחור ז[רי]חת השמש בהם]; for at that hour the sun has not yet risen [כי עתה לא עלה השמש] [?] the globe [הכדור] [?]. And so likewise [?] the matter of the time of the sun's setting [כמו] [?] ענין עת שקיעת השמש] [?] and the hours [?]

[Margin: outer (left) margin. A single display letter stands alone in the head margin — the folio numeral. Both its legs join the top bar, which gives ח (= 8); ת is disfavoured because there is no foot-kick on the left leg, and ה is excluded because the left leg is attached, not detached. Below it, the pale grey hooked strokes and broken rings already recorded on the earlier leaves, in the substance of the paper. Only a narrow strip of this margin is in front of me. I therefore cannot say whether a marginal gloss stands further out on this side; absence from this report is not absence from the leaf.]

— midday and midnight [חצי היום וחצי הלילה]. It emerges that every single degree [ונמצא כי בכל מעלה ומעלה] has a horizon [יהיה לה אופק] of its own [?], [?] and according to the measure of the distance of the horizon of that degree [וכפי מרחק אופק המעלה ההיא] [?] its horizon [יג/ג/בה] [?] that degree [המעלה ההיא] [?].

[?] from the eastern horizon [מאופק המזרחי] it will be [?] [שעה] degrees [מעלות] [recte: שעה], so its horizon [כן האופק שלה] [?] [יג/ג/בה] above the horizon [המזרחי של כדור הארץ] — the eastern horizon of the globe of the earth [מעל אופק] — by [?] [עש] degrees [מעלות]; and this [?] [?] is the measure by which the time of the sun's rising there is delayed [השיעור יתאחר זמן זריחת השמש בה].

The like holds in the matter of setting [וכן כיוצא בזה בענין השקיעה], for by just this much [כי כעצם זה] [?] its western horizon sets [שע/ד/ר] degrees [שקע] [שע/ד/ר] beneath the western horizon of the globe of the earth [תחת אופק המערבי של כדור הארץ]; and the measure [ושיעור] [?] — that will be the time of the sun's setting there [רק יהיה זמן שקיעת] [החמה שם].

The rule that emerges is that you have no degree whatever [הכלל העולה כי] [?] varying by the measure of the division of the degrees [אין לך מעלה ומעלה] [המשתנות כשיעור חלוק המעלות], which does not have [שאין לה] a horizon peculiar to itself on the eastern side and on the western side [אופק מיוחד לה מצד מזרח] [ומצד מערב]. It emerges, therefore, that the times of rising and of setting vary [ונמצא כי עתות הזריחה והשקיעה משתנות] from degree to degree according to the difference of their distances from the eastern horizon [בכל מעלה ומעלה כפי חלוק] [?] as in the matter of breadth [כענין רוחב] [?].

[?] the degree [המעלה] [?] no degree [אין מעלה] [?] and it will stand [ותעמוד] [?] near [?] distance [מרחק] [?] and the setting [והשקיעה], for all the degrees that are of the measure [כי כל המעלות אשר הם כשיעור] [?] a difference of one degree [?] [עם מרחקם] [?] with their distance [חלוק א' מעלה] [?] their rising and their setting is equal, as at the beginning [זריחתם ושקיעתם שוה כבתחלה]; and therefore they occupied themselves [ולכן התעסקו] [?].

The sages [חכמים] — [?] the division of the lands [חלוק המדינות] [?] on the globe [בכדור] [?] — for according to the measure [כי כפי שיעור] [?] [?] and their setting [ושקיעתם]. And we shall set out [ונבאר] [?] a little [קצת] [?] as above [כנ"ל] [?] as in this matter [כענין זה]. And here it has been shown [והנה נתבאר] that from the eastern horizon [כי מאופק המזרחי] as far as the western horizon [עד אופק המערבי] of the upper half [של חצי עליון] [?] of the globe of the

numeral, not a mark on this side: it is the same size and shape, it is brown rather than black, and it sits at the mirror position of the recto's numeral across the leaf's vertical axis. It is therefore the same ink seen from behind, and it is not an independent second witness to the numeral. The pale grey watermark strokes stand in this margin at the position mirroring the recto's. Nothing else is in this margin, and no gloss stands on this side within the region I could read; that region stops short of the fore-edge and the leaf continues beyond it, so I cannot speak for what lies further out.]

— the diurnal sphere [הגלגל היומי], which is called the equinoctial line [כי בו נודע שיעור]; for by it is known the measure [הנק' קו השוה] of the division of the days and the nights and their variations [חלוק הימים והלילות ושינויים] according to distance [כפי מרחק]. • [?] the latitude of the localities [ר]חב המדינות], as will be shown [?], with God's help, below [כמו ש?] בע"ה לקמן]; and the matter [והענין] [?] — for from it is known the measure of the hours of the day and of the night [כי ממנו יודע שיעור שעות היום והלילה] in every [בכל] [?] of the degrees [המעלות].

For there is a locality in which, throughout its whole motion [?] [כי יש מדינה שבכל תנועתה] [?] in summer and in winter the day and the night are equal [בקיץ ובחורף היום והלילה שווים] — thus twelve hours [כך י"ב שעות] of day and twelve hours of night [היום וי"ב שעות הלילה]. And there are degrees in which, in summer [ויש מעלות שבקיץ], their days are long and their nights short [יהיו ימיהם ארוכים ולילותיהם קצרים], and in winter [ובחורף] their days are short and their nights long [ימותיהם קצרים ולילותיהם ארוכים] — as in the places [במקומות] [?]; and there are places in which the reverse of this holds [ויש מקומות שהיפך זה], varying [משתנים]; and there are degrees for which six months of summer are day [מעלות שהם שש חודשי הקיץ יום] and six months of winter are night [ושש חודשי החורף לילה]; and there are degrees where the reverse of this holds [ויש מעלות שהיפך מזה].

And all [וכל] [?] one knows well the latitude of the locality [יודע מאד רוחב המדינה]. • And the north [?] [כי אם קו] [?] the body of the sun [היה מכוון תמנעש] [?] [כוכב השמש] were always aligned [?] [הנה אז היו כל] [?] then all the days and all the nights in every place [הימים וכל הלילות שבכל המקומות] would be twelve hours by day and twelve hours by night [י"ב שעות ביום וי"ב שעות בלילה] [?]; the times of rising and of setting would be in them according to the distance [בהם עתות הזריחה והשקיעה כפי מרחק] [?] of the division of the degree [חלוק המעלה], and the day [?] and the night would have no variation in them at all [והלילה לא היה בהם שינוי כלל] [?] since the sun [לפי שהשמש] on all the days would be on that line [בכל הימים בקו ההוא] [?] as was shown above [כמו שנת' לעיל] [?] according to [כפי] [?].

[?] the sun [השמש] in which they were, and they fixed [שבו ותקנו] [?] over against the sun itself [נגד השמש עצמו], and it is not [ואינו] [?] the diurnal [היומי], as will be shown [?] in chapter [numeral: ?] [כמו ש?] [בפ"]; and inasmuch as the sphere of the degrees [וכפי כי גלגל המעלות] [?] — [?] the stars [הכוכבים] [?] and their equinoctial line [וקו השוה שלהם] [?] their positions [מקומם]; [?] their

line is equal [?] [הקו שוה שלהם], [?] toward the north side of the equinoctial line [הקו של קו השווה] of the diurnal sphere [היומי], and at times it inclines toward its south [ולפעמים נוטה לצד דרומי], as [כמו] ·

For when the sun [?] [כי כש], which revolves [המסבב] [?] [?] [?], [?] in its own sphere [בגלגלו עצמו] [?] one complete revolution [סיבובו א' שלם] in the year [ימות השנה] [?] the days of the year [בשנה] [?] as was shown in chapter [numeral: ?] [בפ"ג] — here, then, it is not on each day [מתנועת מן נק' לנק'] [?] moving from point to point [הנה לא בכל יום] throughout the days of the year [בכל שנה ימות השנה]; and when the diurnal sphere revolves it [וכאשר גלגל היומי מסבב] —

[?] the body [הככב], the reverse of its motion [הפך תנועתו] — here, then, this day [הנה היום הזה] [?] a day [?] [?] from a degree [?] [שמן מעלה], pointing [?] [מורה] at one point in the hour of the morning [בנק' א' בעת הבקר], at [?] point [?] [שגלגל של השמש עצמו] [?] one [א'], that the sphere of the sun itself [ומסבב] [?] and it was not found equal [ולא נמצא שווה] [?] and it revolved it [?] [בנק' אחרת], and in the morning of the second day [ובבקר יום הב'] they found that it had moved away from [מצאו שנתרחק מן] the line [הקו] [?] at another point [בנק' אחרת], and it returned and revolved it again [וחזר ומסבב].

Diagram. The figure occupies rather less than the lower half of the leaf: it sits low on the page, toward the gutter (left) side, and protrudes past the text block's left edge into the margin. The body lines that pass its height are shortened at their left ends and continue to its right.

The construction. Two concentric circles : the inner circle's radius is about four-fifths of the outer's, leaving a band between them about a fifth of the outer radius wide. Through the centre run three full diameters, each crossing the band and terminating on the outer circle: one horizontal; one vertical; and one set obliquely, rising from the lower left to the upper right. The oblique crosses the horizontal at a shallow angle — at the rim it stands a little below the horizontal on the left and correspondingly above it on the right, which is about 13°. That is my measurement off the plate; the figure states no value for it.

From the centre a fan of thin radii rises, drawn outward only as far as the inner circle and stopping there — so they are radii of the inner circle, not of the outer. The fan occupies a narrow sector that straddles the vertical diameter. [Superseded, preserved verbatim: "The fan occupies a narrow sector that straddles the vertical diameter and leans to the upper left. I count eight thin radii; where they converge on the centre they cease to separate, so eight is a floor and not a census."] The radius bounding the fan on its upper-left side is drawn heavier than the thin ones, and it alone among them continues across the band to the outer circle.

The band between the circles is divided into compartments by short radial cross-rules — at the ends of the three diameters and at the heavier upper-left radius. Four compartments carry lettering: two at the upper left (stacked, following the curve), and two at the foot, flanking the lower end of the vertical diameter.

Colour. Both circles, all three diameters, every radius of the fan and every cross-rule of the band are drawn in gold — matte and granular, unrubbed. Every letter on the plate is in the ordinary brown-black ink of the body text, not in gold. There is no red and no blue anywhere in the figure; the only red on the leaf is the border rule at the foot, which is a ruling, not writing. A single pale blue-grey speck, minute — roughly a fiftieth of the outer circle's radius across — lies on blank paper inside the outer circle, near its left flank a little above the horizontal diameter; it touches no rule and no letter, and I do not offer it as evidence of blue pigment. Show-through from the recto crosses the whole figure as brown horizontal banding, and I have taken none of it for a rule.

Labels — a census of what is inked on the plate.

Read:

- גלגל השמש — "the sphere of the sun". In the band at the upper left, curving with the arc. The clearest lettering on the plate; the two shins of השמש are unmistakable.
- גלגל היומי — "the diurnal sphere". In the same band immediately above and outside the preceding. גלגל is secure on four sorts. On the second word the article does not separate from what follows it, so גלגל יומי is not excluded; the יומי sorts themselves are sound.⁵
- [זה קו ע] [ב/כ] השמש [?] — "this is the line of the [?] of the sun". Written along the oblique diameter on the upper-right side, beginning at the rim inside the band and running inward toward the centre.⁶
- [זה קו ע] [ב/כ] גלגל היומי [?] — "this is the line of the [?] of the diurnal sphere". Written along the horizontal diameter, just beneath it, in the same manner and running the same way.
- מזרח — "east". Outside the circle, below it, centred under the foot of the vertical diameter. Four sorts, drawn larger than the band labels.

Not read:

- Top of the plate, directly above the head of the vertical diameter and outside the outer circle. One word, about four sorts, small and curved to follow the arc; I separate none of them. Fails on SIZE, not on orientation. It stands at the opposite end of the vertical diameter from מזרח.
- Two labels in the band at the foot, one on each side of the lower end of the vertical diameter, each set radially, at about 90° to the page. The sorts are of ordinary size and appear sound. These fail on ORIENTATION,

⁵היומי confirmed — legible in CBL's own ink in a wider low-magnification strip; NLI 9573 writes גלגל יומי / גלגל היומי at the answering position. The article/no-article variation stands as recorded.

⁶opening word confirmed זה at the head of both axis labels, in a strip extended east past the earlier crop edge; the מ/ז reservation is lifted. △ NLI 9573 carries the answering labels without זה — a genuine variant between the witnesses, not corrected.

not on size. I cannot tell from the unrotated view which way the sorts face, so a rotation in each sense will settle it in one look.

- A mark at the outer end of the horizontal diameter on the right, just outside the rim — a long vertical stroke with a smaller sort above it. It is not part of the prose: the filler dash that ends the body line at that height stands to the right of this mark, so the mark lies outside the written line. Fails on ORIENTATION and on size together.
- [Superseded — now READ. At the outer end of the horizontal diameter on the LEFT.] The earlier note stands verbatim: "Black ink stands immediately outside the rim and runs off the left boundary of the supplied region. Only a narrow sliver of paper — roughly a twentieth of the outer circle's radius — stands between the rim and the cut. I have read nothing from it and reconstructed nothing. By position it is the counterpart, at the other end of the same diameter, of the vertical mark recorded immediately above. A re-cut carrying the whole left flank is needed." — and the re-cut was made. The label reads דרום [recte: דרום], "south". A later probe read it as four sorts [[כ/ר]] · [[כ/ר]] · ו · [[כ/ב]] and refused it; that refusal is lifted, on the grounds set out in the plate-label QA note below.

[— five items of lettering on this figure are unread: one on size, two on orientation, one on orientation and size together, and one cut by the crop.]

[Margin: head margin, toward the outer (left) side. A single display letter stands alone there — the folio numeral. It is a broad cup whose left stroke curls inward at the top and whose right stroke rises clear: I read ט (= 9). ח is disfavoured because ח in this hand is a gate — two straight legs joined by a plain top bar — with no inward curl at the top left. Only a narrow strip of the outer margin is in front of me. I therefore cannot say whether a marginal gloss stands further out on this side; absence from this report is not absence from the leaf.]

All the days [כל הימים] until the completion of the sun's revolution in the sphere [עד תשלום סיבוב השמש בגלגל] [?] [numeral: ?] days [ימים] [?], and it does not return to the place [ולא חוזר להמקום] like the point [כנקו'] [?] — [?] and it returns and draws near [?] [וחוזר ונתקרב] [?] days [ימים] [?] after them [אחריהם] [?]. And this [וזה]

is the case in every single year [דבר בכל שנה ושנה]. • Let us return to our subject [ונחזור לעניננו]: if the equinoctial line of the sphere of the sun [כי אם קו] were aligned [היה מכוון] beneath the equinoctial line of the diurnal sphere [תחת קו השווה של גלגל היום] — then, though the sun revolves in its own sphere and shifts from place to place [הנה שהשמש מסבב בגלגלו ונעתק ממקום] on each and every day [בכל יום ויום], even so [עכ"ז] [?] its course and its revolution would always have been [לעולם היתה מהלכו וסיבובו] [?] only the equinoctial line of the diurnal sphere alone [רק קו השווה של גלגל היומי בלבד] [?].

Now [עתה], since its equinoctial line inclines away from the equinoctial line of the diurnal sphere [שקו השווה שלו נוטה מקו השווה של גלגל] [?] — which is also [שהוא ג"כ] [?] the equinoctial line of the globe of the earth [קו השווה של כדור הארץ], as above in chapter [numeral: ?]

[?] [נעלם] [?]: for although it moves uniformly always [רק קו השווה שלו] — behold, [כי גם שהוא מהלך בשווה תמיד] it is carried round [הנה הוא מתגלגל] [?] and revolves and inclines at times to the north of [ומסבב ונוטה לפעמים לצפון] the equinoctial line of the world [קו השווה של העולם], at times to its south [לפעמים לדרום], as [?] in chapter [numeral: ?] [כמו ש?] [בפ"].

For [?] six [?] months of summer [כי ו' חדשי הקיץ] it inclines toward the south side of the equinoctial line of the [?] [?] six months [נוטה לצד דרום קו השווה של ה] [?] [?] and in all [?] [?] [?] [ובכל].

[?] each day the sun's [?] line of motion differs [תנועה] [יום ויום ישתנה השמש קו א'] from its fellow [מחבירו] [?] — [?] [?] as [?] above in this [כמו ש?] [לעיל מזה] [?] [?] from the beginning of the tekufah [מתחילת תקופת] [?] [?] until [עד] [?].

And it emerges [ונמצא] that [?] the sun [השמש] [?] months [חדשים], which are 180 days [שהם ק"פ ימים] [?] — [?] according to the measure, in the manner of those lines [לשעור כדרך הקוים ההם] [?] it revolves [סיבב] [?] line by line [בכל קו וקו] [?] its reverse motion [תנועתו הפכיית] [?] and afterwards, in the six months that follow them [ולאח"כ ב' חדשים אחריהם] [?] it returns to [חוזר ל] [?].

****]

[?] the same course [דרך] [?] first [קודם] a circuit of lines complete [הקף קוים בשלמות] [?] and it emerges that it was [ונמצא כי היה] [?] to draw on the diurnal sphere [לצייר בגלגל היומי] [?] a circuit of lines [הקף קוים], and they would be [ויהיי] brought near one to another [מקורבים זה לזה] [?] and the measure of the breadth of every [?] of the lines [קוים] [?] would be [?] as the measure of the portion of the inclination of the equinoctial line of [כשיעור] [?] [החלק נטיית קו השווה של].

The sun [השמש], from the equinoctial line of the diurnal sphere [מקו השווה של גלגל היומי], from above [מלמעלה] [?] to the farthest limit of the south [לתכלית הדרום] — twenty-three [?] degrees and a half [כ"ג?] [מעלות וחצי] [?] of the globe [של הכדור] [?] and correspondingly its inclination [וכנגדה נטייתו] [?] [?] and toward the [north/small — not separated] side [צפון/קטן] [?] twenty-three [?] degrees [כ"ג?] [מעלות]; and it emerges [ונמצא] [?] [?] from the circuit [מן הקף], the whole breadth being forty-seven [?] degrees [כל רוחב מ"ז?] [מעלות] [?] [?] and the whole breadth [וכל רוחב] [?] forty- [?] degrees [מ"ד?] [מעלות] [?] or they were divided [או נתחלקו] [?] a circuit of lines [הקף קוים] to the south and to the north of [לדרום ולצפון] the equinoctial line of the world [קו השווה של העולם], according to the measure by which they revolve [לשעור בהם מסבב].

The sun, on each day, at a point [השמש בכל יום בנקו], is carried round [מתגלגלת] from its fellow [מחבירו], as above [כנ"ל] [?]; and it emerges that the locality [ונמצא כי המדינה] [?] according to the measure will be standing [לשעור תהיה עומדת] [?] — [?] you will find it in the equinoctial line of the globe of the earth [תמצא בקו השווה של הכדור הארץ] [?] the sun [השמש], whether in [?] or in its degree [בין ב?]. So, then, when [הנה כאשר] it makes equal and divides the diurnal sphere into minutes [תשווה ותחלק גלגל היומי לדקות] according

to the measure, on every [?] day the sun revolves through the minutes [לשעור] from its fellow, as noted above [מתחלפת] [?] [א' מהן] differing [בכל יום יסבב השמש בדקות], one of them [מחבירתה כנרשם לעיל]. Here, then, it is pressed close [הנה נדחק] [?] that the whole globe [שכל הכדור] [?] the minutes are equal and aligned, whether toward the south side [הדקות שוות ומכוונות בין לצד דרום], thus. ·

Toward the [north/small — not separated] side [לצד צפון/קטן] [?], because when the locality is [לפי שבהיות המדינה] [?] [?] the globe [כדור] will not stand far off from those who dwell [לא ירחק אל היושבים] [?] [בכל] [?] the [?] line [זה], at the point of the line of the [?] horizon [ה] [בנקו' קו האופק ה], the southern [הדרומי]; and this at the point of the line of the northern horizon [וזה בנקו' קו האופק הצפוני], and the horizon [והאופק] of the world is even [של העולם שוה]; and the uprightness [?] of the lower one [ויורש התחתון] is revealed before him [מתגלה לפניו], and always [ויעולם] [?], when the sun reaches the line of the eastern horizon [בהגיע] [?] it will be strong [?] like that one [יחזק כמותה ההיא]; and when it reaches the western horizon [ובהגיעו לאופק המערבי] · it will set [ישקע], and by this means [וע"י כך] all the days and the nights would be equal [יהיו כל הימים והלילות שוין].

****]

[Margin: outer (right) margin — no folio numeral, as expected on a verso. A faint brown ט-shaped mark stands in the head margin toward the outer (right) side, level with the recto's folio numeral. It is show-through of the recto's folio numeral, not a mark on this side: same size and shape, brown rather than black, and at the mirror position across the leaf's vertical axis. It is not an independent second witness to the numeral. The margin was examined out as far as the red frame rule at the fore-edge, and it is clean paper throughout — no gloss stands in the outer margin of this side.]

— in summer and in winter [בקיץ ובחורף], the same as that one [כמותה ההיא], for all the motions that have breadth [לכל התנועות שיש להם רוחב], which stand away from the equinoctial line of the globe of the earth and of the diurnal sphere [המתרחקות מן הקו השוה של כדור הארץ וגלגל היומי] toward its [north/small — not separated] side [לצד צפון/קטן]. And here the globe of the earth is round [?] [?] [?] beneath the equinoctial line [תחת הקו השוה]; and everything that stands away to the north or to the south [וכל מה שמתרחק] [?] [?] and more [ויותר]. And therefore [ולכן], the nearer that locality draws to the north [כל אשר תתקרב המדינה ההיא לצפון] [?] the more it is disclosed how [יתגלה איך] the north pole [קוטב הצפון] draws near [ויתקרב] [?] the south pole [קוטב הדרום] to be [להיות] [?] [?] and the north pole stands away from it [ועלה מן] [?]; and according to how far [?] stands off from it [וכפי מה שירחק] [?] [?] pole [?] [?] the like of it [כמותה] [?] the southern [הדרומי], and it is covered [ויתכסה] [?] and beneath the horizon of the locality [ויתחת לאופק המדינה] [?] over against the [?] pole [ו] [כנגד קוטב ה] the line of the horizon of the world will be [יהיה קו האופק של העולם]; their equinoctial line will be the one that passes over

[?] the line of the pole [קו הקוטב], over against the heads of the people who dwell [נגד ראשי האנשים השוכנים] [?].

[?] its breadth grows strong [יתחזק הרוחב שלה], its poles change [ישתנו קוטביה], and the equinoctial line [וקו השווה] [?] the horizon and the equinoctial line of the first locality [אופק וקו השווה של המדינה הא'] that have [שיש להם] another breadth [רוחב אחר]. And as we depict for you here [וכמו שאנו מצייר לפניך זה] — and it emerges that the locality is seated at the pole [ונמצא כי המדינה מיושבת בקוטב].

[?] the north [הצפון], the north [?] pole will be [יהיה קוטב הצפון], and so the line of the horizon of the diurnal sphere [כן קו האופק גלגל היומי] stands opposite the heads of those people [נוכח ראשי האנשים ההם]; and their equinoctial line is covered from them [ויתכסה אצלם קו השווה שלהם]. And so always [וכן לעולם] [?] the line of the horizon is what is found above the heads of the people who dwell in that place [קו האופק הוא מה שנמצא על ראשי האנשים השוכנים במקום ההוא].

And it emerges [ונמצא] that the equinoctial line of the diurnal sphere [הוא להם קו האופק] is for them the line of the horizon [כי קו השווה של הגלגל היומי]. And so, in this same measure [וכן כפי שיעור זה], in every one of the degrees [בכל המעלות] it increases [?] according to [ותרבה כפי] [?] their standing away from [הקו השווה אל הצפון] [?] the equinoctial line toward the north [התחזקם מן] so the northern horizon rises for them [כן יגבה להם אופק הצפוני] and the southern horizon descends [ויורד אופק הדרומי]. And [?] their horizon must change [צריך שהאופק שלהם ישתנה] and be raised above the horizon of the world [ויהיה גובה מאופק העולם] according to the measure of the latitude of that locality from the equinoctial line [כפי שיעור רוחב המדינה ההיא מקו השווה], as [?] we have explained [ע"ן] [?] [?].

For just as, according to the measure of the longitude of the locality, the eastern and the western horizons change [כי כפי שיעור אורך המדינה ישתנו האופקים] [?] the breadth [רוחב] [?] according to the measure of the latitude of the locality, so do [?] change [כפי שיעור רוחב המדינה כן ישתנו] —

Diagram. It sits in the lower two-thirds of the leaf, toward the outer (right) side of the text block and protruding past its right-hand edge; the thirteen body lines that pass its height are shortened at their right-hand ends — that is, at their starts — and run only in the strip between the gutter margin and the plate.

The construction. An outer circle in gold; it is drawn freehand and slightly faceted, the arc breaking into short straight runs between the points where the radii meet it. Concentric with it, an inner circle in red, same centre, its radius a little under half the outer's. At the centre itself a small gold ring, its radius about a fifteenth of the outer circle's.

Two full diameters run through the centre and terminate on the outer circle: one horizontal and one vertical. From the centre a further set of oblique gold radii runs outward to the outer circle, crossing the red circle on the way — I count three above the horizontal and three below it, and because they converge at the small central ring where they cease to separate, three and three is a floor,

not a census. Each of the oblique radii, and each of the two diameters, carries lettering written along it, running outward from the centre toward the rim.

Colour — and this differs from what the earlier plate of this codex showed. The outer circle, both diameters, every oblique radius and the central ring are drawn in gold, matte and granular. The inner circle is drawn in RED — a warm orange-red, opaque and unfaded, and it is the only red in the figure. There is no blue anywhere in the figure. Every letter on the plate is in the ordinary brown-black ink of the body text, not in gold. Separately, the leaf's border rule at head and foot is red, as on every leaf; that is a ruling, not writing. Show-through from the recto crosses the whole figure as brown horizontal banding with mirrored letterforms legible inside it, and I have taken none of it for a rule and transcribed none of it.

Labels — a census of what is inked on the plate.

Read:

- **מערב** — "west". Outside the outer circle, above it, centred over the head of the vertical diameter. Four sorts, drawn larger than the radial labels.
- **מזרח** — "east". Outside the outer circle, below it, centred under the foot of the vertical diameter. Four sorts, the same size and manner as **מערב**.
- **אופק עולם** — "the horizon of the world". Written along the horizontal diameter, just above it, on the right-hand side, running outward from the centre toward the rim.⁷

Read, but rotated on the plate and so read at an angle rather than square:

- **כדור הארץ** — "the globe of the earth". Written along an oblique radius in the lower right, between the central ring and the red circle, set at roughly 45° to the page. The two words are stacked along the radius. **כדור** is secure on four sorts; on **הארץ** the article does not separate cleanly from what follows it.⁸
- **מרכז הארץ** — "the centre of the earth". Inside the inner (red) circle, left of the vertical, running down; the phrase's last sort is the ף descender that the cold probe had isolated as the one characterised sort of an otherwise unresolved 6–7-sort label.⁹

⁷CENSUS VINDICATED. A cold probe struck this phrase out, finding **עולם** alone with "no **אופק** there"; its note stands verbatim below, NOT deleted. Its crop stopped short on the EAST, where an RTL phrase's first word sits, so **אופק** fell outside the box — crop geometry, not ink. On a box carried east to blank parchment **עולם אופק** stands whole and clear; this entry is reinstated.

⁸**כדור** confirmed — the disputed second sort is ד; the phrase stands right of the vertical inside the inner (red) circle, and NLI 9573 writes **כדור הארץ** in the same position. ⚠ Do NOT carry it to f. 10r: the central caption there is **גלגל הארץ**, a different thing, and importing this one would produce a fluent wrong caption.

⁹resolves the probe's UNRESOLVED "left-hand label inside the red circle"; that refusal stands verbatim below. NLI 9573 writes **מרכז הארץ** left of its vertical and **כדור הארץ** right of it. The same phrase is read independently on f. 2r (fig-p3-1, NW diagonal legend); the two readings agree.

- קו שווה המזלות ושמש — "the line that equalizes the signs and the sun". Along the radius next west of the vertical, set at 90° . ¹⁰ ****
- קו שווה העולם — "the line that equalizes the world". Along the neighbouring NE-sector radius. ¹¹ ****
- [קו שווה התנוע] — ****
- [אופק תנוע] ה — "the horizon of the motion of the [...]". Along a shallower oblique radius on the right, between the red circle and the rim. אופק is sound on the same control as the body text; the final word I did not read.
- [קו האופק] ה — twice, along two radii in the upper left: one set obliquely and one lying along the vertical diameter itself. In both, קו and האופק are sound and the word that follows is not.

Not read:

- A label set vertically at the OUTER (right) end of the horizontal diameter, just outside the rim. Four sorts of ordinary size, sound-looking, set at about 90° to the page. Fails on ORIENTATION, not on size. My unrotated impression is צפון, and I am not offering that as a reading — I could not separate its sorts in this attitude, and reading a rotated label unrotated is how a plate produces confident nonsense.
- [Superseded — now READ.] A label set vertically at the GUTTER (left) end of the horizontal diameter, just inside the rim. Taller than the right-hand one, so probably more sorts. Fails on ORIENTATION. — ¹²
- [Superseded — now READ.] A radial label in the LOWER LEFT, between the central ring and the red circle, set at roughly 135° to the page — the steepest lettering on the plate. The sorts look sound and are of ordinary size. Fails on ORIENTATION. — ¹³
- A radial label in the LOWER RIGHT, outside the red circle. I recover תנוע[?] from it and nothing else. Fails on ORIENTATION and on size together.

[— four items of lettering on this figure are unread, all four on orientation, and four more are read only partially. Rotation is free and recovered nothing here because I cannot rotate; every one of these should come back on a single rotated cut.]

¹⁰resolves the probe's PARTIAL שמש ... קו שווה ה[?] ("did not resolve at 8.5x") — not a resolution problem: a narrow box at high magnification strips the neighbouring word and the shared קו שווה prefix, which are what identify the letters. At low magnification, both radial labels and their bounding radii in one frame, it reads at once. Its relation to תנוע[קו שווה התנוע] is NOT settled here — see QA.

¹¹resolves the probe's קו שווה ה... "remainder unresolved", read in the same low-magnification frame. Same reservation about its relation to the earlier census entries.

¹²rotated and read: דרום, "south". Four sorts: ד (squared bar/leg join) · ר (rounded arc join) · ם closed. This closed final ם is the control that disposes of the f. 8v inference that an open final sort made that leaf's west label "a different word" — see the QA note below.

¹³now read as מרכו הארץ, entered in the "Read" list above; kept here rather than deleted so the earlier refusal and its blocker survive.

[Margin: head margin, toward the outer (left) side. A single display letter stands alone, level with the running header — the folio numeral. One narrow stroke with a small head and no descender: I read י (= 10).]

its southern horizon and the [northern / lesser] one [אופקיה הדרומי לשעור שם] [?], to gauge there the place of the station of the poles [מקום מעמד הקוטבים] [?]. And it emerges that when [ונמצא כי כאשר] [?]

[?] the horizon of the world [אופק העולם] — from them [מהם] [?] to the north [לצד הדרום] [?], and it is brought low [ויושפל] [?] toward the south side [להיות להם אופק אחר שווה], in which

the sun rises and sets [יזרח וישקע השמש]. Then their northern horizon will stand lower than the northern horizon of the world [ואז יהיה האופק הצפון שלהם] [נמוך מאופק צפון העולם] [?], and their southern horizon [ולאופק הדרומי שלהם]

higher than the southern horizon of the world [גבוה מאופק דרום העולם] [?], as [?] [ונמצא כי] — in this degree [במעלה זו] [?]. And it emerges that [?]

when we reckon minutes in the diurnal sphere, by whose measure the sun revolves on each day [כאשר נחשוב דקות בגלגל היומי לשעור בהם יסובב השמש בכל יום] [?], as above [כנ"ל] — behold, the divisions of the minutes [הנה חלקי הדקות]

[?] on the [northern / lesser] side [בצד צפון/קטן] [?]: the upper division of the sphere, above the horizon of the world, will be more [למעלה מן אופק העולם יהיו יותר]

long and large than those minutes [ארוכות וגדולות מאותם הדקות] [?] beneath the horizon of the world [תחת אופק העולם], because their [southern] horizon [לפי שהאופק הדרום? שלהם]

stands lower than the horizon of the earth [נמוך מאופק הארץ] [?] on the [northern / lesser] side; and on the southern side it is the reverse [ובצד הדרום הוא להפך] [?], for the upper [division] of the minutes will be [כי יהיה העליון של הדקות]

[?] there, above the horizon of the earth, more [למעלה מאופק הארץ] [?] the lower [division] of the minutes [התחתון של הדקות] [?]

[?] there, beneath the southern horizon of the world [מתחת אופק העולם הדרומי], because their horizon stands higher than the horizon of the earth in the south [לפי שהאופק שלהם גבוה מאופק הארץ בדרום]

And it emerges that when the sun is at the extremity of the tekufah [ונמצא כי בהיות השמש בתכלית מהתקו'] [?] of the [north / lesser], which is when [?] [שהוא כעת תקופת תמוז] [?]

— that is, at the season of tekufas Tammuz [שהוא כעת תקופת תמוז] [?] — then the day runs the longest and the night the shortest of the whole year [אז הולך היום] [?].

And this holds in every settled place [וזה יהיה בכל מקומות הישוב] [?], except the degrees that lie under the equinoctial line of the world [זולתי המעלות שתחת קו] [?], as above [כנ"ל]. And when

[the sun stands] at the extremity of the tekufah toward the south [בתכלית מהתקו' לצד דרום] [?], which is at tekufas Teves [שהוא בתקופת טבת] [?], on its reaching [בהגיעו] [?] — then runs

the day the shortest and the night the longest of the whole year, throughout the settled world [היום היותר קצר והלילה היותר ארוכה שבכל השנה בכל הישוב], as above [כנ"ל]. · And when [וכשיהיה]

[?] the place stands over against the equinoctial line of the world [המקום כנגד], then the days and the nights are equal in all the degrees [אז [קו השווה של העולם הימים והלילות שוים בכל המעלות]

of the settled world; and this occurs at tekufas Nisan and at tekufas Tishrei [וזה יהיה בתקופת ניסן וכתקופת תשרי], and that is what is called the equinoctial line [וזהו שנק' קו השווה]; for when there reaches

the sun [?] over against it [כנגדו], then the days and the nights are equal throughout the settled world [אז הימים והלילות שוים בכל הישוב]. And it emerges that the measure of the length [ונמצא שיעור אורך]

of the [?] ones or the near ones [ה[?] או הקרובים] is according to the breadth of the degree [הוא כפי רוחב המעלה]; for the more the latitude of a locality draws near [כי כל מה שיתקרב רוחב מדינה]

to the [northern / lesser] side [לצד [צפון/קטן]], the upper division of the [?] minutes will be very long, and the lower division very short [היה חלק העליון של [הדקות ה[?] ארוכות מאד וחלק התחתון קצרות מאד];

and the reverse on the southern side, for the upper divisions will be short and the lower long [ול הפך בצד דרום כי חלקי העליון יהיו קצרות והתחתון ארוכות], until it emerges that the degrees [עד שנמצא כי המעלות]

[?] at the [northern / lesser] pole [בקוטב ה[צפון/קטן]] the equinoctial line of the world is their horizon line [קו השווה של העולם הוא קו האופק שלהם]

[?] the sun is disclosed to them, revolving [יתגלה להם השמש מסבב] above, at the decline of summer [למעלה בשיפול הקיץ]

the motions round about and not from above [התנועות מסביב ולא מלמעלה] [?]. And it emerges that, through all six [?] months of summer [ונמצא כי כל ו' חדשי הקיץ], all the degrees

in which the sun revolves — on the [northern / lesser] side — are disclosed to them always, to their horizon, which is [שבהם מסבב השמש בהם בצד [קטן/צפון]] [הם מתגלים להם תמיד לאופק שלהם שהוא]

the equinoctial line of the world; and always it is for them [day?] [קו השווה] and not [?] — days, all of them [?] nights — all six months of summer; and likewise the months [לא ימים כלם לילות כל ו'] [חדשי הקיץ וכן חדשי]

[?] the sun revolves beneath the equinoctial line of the world, which is their horizon line, in the degrees [השמש מסבב תחת קו השווה של העולם שהוא קו האופק] [שלהם במעלות]

[?] there; and the sun stands off from them through all six months of winter, and always it is night for them, all [of it] [לשעור שם והשמש מתרחקת מהם כל ו' חדשי] [החורף ותמיד הוא להם לילה כלו]

[Margin: outer (right) margin — no folio numeral, as expected on a verso. The margin is clean paper as far out as I can see it, and carries no gloss.]

the day [יום] [?] in its plain sense [כמשמעו] [?] according to [כפי] · And the reverse holds [ול הפך הוא] [?] for the degree that lies beneath the southern pole [כמעלה שתחת קוטב הדרומי]: the six[?] months

of summer are nights for the inhabitants of the [north / lesser] של [?] [יושבי ה] [צפון/קטן] הוא לילות להם [?] months of winter are days for them [ווי' חדשי החורף הוא ימים להם] and the reverse [?]

the matter [הענין] [?] into the degree [לתוך המעלה] [?] as above [כנ"ל], and [?] in it the degree that stands far from the line [המעלה הרחוקה מן קו]

of equinox of the world. And I have shown you how its own equinoctial line and its own horizon line change and shift away from the line [השוה של] העולם והראיתך איך קו השוה וקו האופק שלה משתנים ונועים מהקו

of equinox and the horizon line of the world; and so too the sun [השוה] [?] [כן בדקות] [?] likewise in the minutes [וקו האופק של העולם גם השמש מצד הדרומי וה] [קטון/צפון] של [?] of [northern / lesser]

the equinoctial line of the world. And I have shown you how, according to the horizon line of that degree, the minutes are found [קו השוה של העולם] [הראיתך איך כפי] [ה] [קו האופק של המעלה ההיא נמצאו דקות]

[?] — the more anything stands off from the equinoctial line toward the [north / lesser] [?] [כל מה שיתרחק מקו השוה אל ה] [צפון/קטן] [?] they are divided [?] the more in the upper divisions and shortened in the divisions [יתחלקו יותר] [בחלקים העליון ויתקצרו בחלקים]

below; and the reverse of this holds in the minutes that lie south of the equinoctial line [התחתון והפך מזה הוא בדקות של דרום קו השוה] for behold, the sun does not revolve ·

according to the horizon of [that degree / the country] [כפי אופק] [?] [or / and not] other degrees, and not according to the horizon of the world; and therefore, their horizon being [לא כפי אופק העולם] [ולכן בהיות אופקם]

changed from the horizon of the world, so also is their sight of [?] the sun as it draws near to them and is hidden from them [משתנה מאופק העולם גם ראייתם] — [את] [?] השמש כהתרחקו אליהם והתעלמו מהם

as it stands off from them — different according to their horizon. And when it revolves in the northern minutes, the day is long and the night [כהתרחקו מהם] [משונה כפי אופקם ובהיותו מסבב בדקות הצפון היום ארוך והלילה]

short; and when it is in the southern minutes, the day is short and the night long [קצרה ובהיותו בדקות הדרום היום קצר והלילה ארוכה]. And behold, this is reversed — the matter of the diurnal sphere [והנה נתהפך זה ענין גלגל היומי]

[?] over against the poles and the lines [?] and the degree of the globe of the earth and of the world [כנגד קוטבי וקוי ומעלת כדור הארץ והעולם]

Moreover, I have made known to you that it revolves [גם הודעתך היותו מסבב] [?] and carries round all the spheres likewise; and in one whole day, from the motion above [מסבב כל הגלגלים כמו כן וביום א' שלם מתנועה למעלה]

Moreover I have made known to you [?] [גם הודעתך] [?] you have known the divisions of the motions and [?] [ידעת חלקי התנועות ו] :

פרק ה

On the explanation of the variation of the [?] of the days and the nights in every clime [אקלי] of our settled world [?] הימים והלילות בכל אקלי] and [?] [של הישוב שלנו]

[?] the measure of [?] of each clime among them — which clime — and afterwards I shall return to the matter [כל אקלים מהם איזה אקלי ואח"כ אחזור אל] [הענין].

I have already made known to you above, in chapter [numeral: א?] [כבר הודעתין למעלה ב/כפ"א], and as I told you there [?] [וכמו שאמרתי לך שם], that [?] [האקלים הם מקו השוה]

of the globe of the earth and onward toward the [north / lesser] side [של כדור] [?] [הארץ והלאה לצד] [צפון/קטן] line [?] — but

there is a measure of twelve[?] degrees and a half from the equinoctial line [?] [יש שיעור י"ב מעלות וחצי מן הקו השוה] to the beginning of the first clime [ואין שם ישוב כלל], and there is no settlement there at all [עד התחלת האקלים הא']

because the sun stands there always over against that place and near to it, and rules with its heat over the place [לפי שהשמש הוא שם תמיד כנגד המקום ההוא] [וקרוב לו ושולט בחומו את המקום]

— that place — and therefore it is no place of settlement at all, but a desolate wilderness [ההוא ולכן אינינו מקום ישוב כלל הוא מדבר שמם] [degrees and a half]

the breadth of the first clime of the settled world begins [מתחיל רוחב] [האקלים הא'] של הישוב [numeral: ?] degrees [ושיעור רחבו הוא] [?] [מעלות]

the [second?] clime [האקלים ה[?]] and its breadth is [numeral: ?] degrees and a half [?] [ורחבו] [?] [מעלות וחצי] · and after it the [third?] clime [האקלים ה[?]] and its breadth is [numeral: ?] degrees and more

you will find · and after it the [fourth?] clime [האקלים ה[?]] and its breadth [numeral: ?] degrees approximately [בקירוב] · and after it the [fifth?] clime [אקלי ה[?]] and its breadth is like

[numeral: ?] degrees · and after it the sixth clime [האקלי הששי], and its breadth [numeral: ?] [?] degrees · and after it the [seventh?] clime [האקלים ה[?]] and its breadth [numeral: ?]

degrees and a half. And although he did not mention [ועם היות שלא הזכיר] [?] specifying the breadth of each clime in particular with exact precision [לדקדק] [?] [רוחב כל אקלים בפרט בדקדוק מכוון]

[?] as the sage measured [כימד החכם] [numeral: ?] degrees and no more [?] [ולא עוד] · [והספיק על חשבון זה עוד י"ב מעלות וחצי]

[Margin: head margin, toward the outer (left) side. Two display letters stand alone, some way below the head of the leaf — the folio numeral. I read יא (= II): a single narrow stroke with a small head, then a two-stroke letter with a slanting body. No gershayim is visible between or above them.]

of the empty region that lies between the equinoctial line and the beginning of the first clime [של המקום הפנוי שיש מן הקו השווה עד התחלת האקלי' הא'], the breadth of the whole will be [numeral: ?]

degrees [מעלות ?] [יהיה רוחב הכל ?]. It emerges that from the equinoctial line to the end of the seventh clime [נמצא מן הקו השווה עד סוף האקלים הו'] and a half [ומחצה] and onward [והלאה] [?] the habitation [הישוב] [?]

and there is in them neither offspring nor [produce / motions] [ואין בהם] — and this because of the great cold there, on account of their being very far from the sun [וזה לרוב הקור אשר שם לסבת רחוקם] [מאד מן השמש].

And therefore we did not reckon it within the seven climes [ולכן לא] · And behold [והנה] [?] the breadth of this settled region [מעלות ?] is [numeral: ?] degrees [מעלות ?]

· less [numeral: ?] and a half [ומחצה] [?], and from there onward there is no settlement there at all [ואילך אין שם ישוב כלל] [?]. And know that from the equinoctial line [to / with] this settlement [זה] [עד/עם] [?] [הישוב]

— the last settled one [האחרון המיושב] [?] — they are [numeral: ?] degrees [מעלות ?] [הם ?] and [numeral: ?] minutes of the divisions of a degree [ומחצה עד קצה] [?], and a half, as far as the extremity [והאחרון המיושב]

of the [north / lesser] [הצפון] [?], [numeral: ?] degrees and [numeral: ?] minutes in which there is no settlement at all [כי ? מעלות ו ? דקים שאין בו ישוב כלל] [?]; of the whole, [numeral: ?] degrees, which are the measure —

[?] this [northern / lesser] globe, the settled one, as above [הזוה המיושב כנ"ל] [?] of the seven climes [של הו' אקלימים] [?] [מהם] [?]

the distance from the horizon in which [המרחק מן האופק שבו] [?] as far as the horizon of the degree [עד אופק המעלה] [?], where the degree of the globe comes to an end [שכלה המעלה של הכדור] [?]; and since —

the world is spherical, as above [העולם הוא כדורי כנ"ל] [?], therefore their parts are not equal [לכן אין חלקם שווה] [?] [?] that the [?] clime [האקלי' ה?], being according to the measure of the globe [להיות כמדת הכדור] [?]

· near to the equinoctial line [קרוב לקו השווה] [?], where lies the utmost distance [של קצה הכדור שהוא] [?] [?] of the extremity of the globe, which is [numeral: ?] degrees over against them [מעלות כנגדם] [?]

at the extremity that is in the globe [בקצה שבכדור] [?] and every clime [וכל האקלים] [?] differs from its fellow [מחלוק חבירו] [?] from its breadth to the portion [מרחבה לחלק] [?]

of its breadth, until the seventh clime is completed [מרחבה עד שנשלם האקלי' הו'], is the measure of a fifth of the circumference of the globe [הוא שיעור חומש היקף הכדור] [?], which are [numeral: ?] degrees [מעלות ?] [שהם ?]

which are [numeral: ?] thousand and [numeral: ?] miles [אלף ו ? מילין] [?] [?] and this on account of the roundness of the globe [וזה לסבת עגולת כדור] [?] [?] at the extremity [בקצה] [?]

And therefore he was exact in making known to you how great the whole globe of the earth is [ולכן דקדק להודיעך כל כדור הארץ כמה הוא] — that is its measure. And know that, just as the sphere of the firmament is divided [דע כי כמו שהגלגל הרקיע נחלק]

into [numeral: [ש"ס]] degrees, so too the globe of the earth is divided into [numeral: [ש"ס]] degrees [לש"ס מעלות וגם כדור הארץ נחלק לש"ס מעלות]; and because[?] the globe of the earth is exceedingly small [שכדור הארץ קטן] [למעוט?]

[ומעלות] and the degrees of the globe, and their parts, are exceedingly small [הכדור וחלקיה הם קטנות במאד]

[?] and every single degree [וכל מעלה ומעלה] [?] than the breadth [מרוחב] [?] of the degrees of the sphere [מעלות הגלגל]; therefore every degree of the [numeral: [ש"ס]] degrees

of the globe [הכדור] stands over against[?] the degree of the [numeral: [ש"ס]] degrees of the sphere [מעלות הגלגל] [ש"ס מעלות של ש"ס מעלות הגלגל]; and as I have said before you here [וכמו שאמרתי לפניך כאן]

[?] the globe [כדור] [?] two spheres [ב' גלגלים], and even so the upper one is exceedingly great [וכ"ז העליון הגדול מאד]

[?] exceedingly small [קטן מאד], and even so the breadth of one degree of — the globe stands exactly over against the breadth of one degree of the sphere [הכדור מכוונת כנגד רוחב מעלה א' מן הגלגל].

This [הזה], and the sages of [astronomy / understanding] have already investigated and ascertained [וכבר חכמי ה' תכונה/תבונה] [חקרו וידעו] that the breadth of every

degree of the [numeral: [ש"ס]] degrees of the globe of the earth is [numeral: ?] miles [מעלה מש"ס מעלות כדור הארץ היא [?] מיל]

less a third of a mile [פחות שליש מיל]; and every mile is [numeral: ?] thousand cubits [וכל מיל הוא [?] אלפים אמה]

[?] and according to this reckoning the measure will be [וכפי חשבון זה יהיה שיעור]

of the breadth of all [numeral: [ש"ס]] degrees, which are the circumference of the revolution of the globe [רוחב כל ש"ס מעלות שהם היקף סיבוב כדור]

of the earth, [numeral: ?] thousand and [numeral: ?] hundred miles [הארץ [?] וכבר ידעת] [יהיו [?] אלף ו[?] מאות מילין]

Diagram. Set into the lower part of the written area, toward the gutter side, with the last nine lines of the page shortened and running past it on the outer side. Two concentric circles: an outer circle drawn in matte granular gold, and, sharing its centre, a smaller circle in opaque orange-red, of a little under half the outer diameter. Eight gold radii run from the orange-red circle outward to the gold circle, dividing the ring between them into eight sectors; the radii stop at the orange-red circle and none of them crosses it. The outer circle spans about a third of the written measure across, and stands in the lower part of the leaf. There is no caption above, beside or below the figure — the line immediately above it is ordinary body text, and the paper below it is blank to the foot.

Three labels in black ink stand on the figure. They are set at angles to the page, not level with the body lines, and at the resolution available to me only the first of them yields letters I will commit:

- Centre, inside the orange-red circle: כדור הארץ — "the globe of the earth" — set upside-down relative to the page. ****
- In the ring, on the upper-outer side, written along its radius and inclined roughly sixty degrees to the line of the text: two words, of about four and five sorts. First word רוחב ("breadth"); the second word remains unread [?].¹⁴
- In the ring, on the lower side, set upside-down relative to the page: two words. Not read. [?]

[Margin: outer (right) margin — no folio numeral, as expected on a verso. The margin is clean paper as far out as it is covered, and carries no gloss. A dark blotched mark about the size of two sorts stands in the outer head margin, level with the running header; its strokes are mirrored and it sits clear of both the header and the border rule. It is offset or a stain, not writing of this leaf, and nothing is transcribed from it.]

as above: whatever has three handbreadths in its circumference has one handbreadth of breadth [כנ"ל כל שיש בהיקפו ג' טפחים יש בו רוחב טפח]; and [the sages] [ולחכמים] [?] did not stand on the exactness of the reckoning [לא עמדו על הדקדוק החשבון]

[?] approximately [בקירוב], as [?] wrote there [כמו"ש [?] שם]. But the true measure is seven parts of twenty-two parts [אבל השיעור האמיתי הוא ז' חלקים מכ"ב] [חלקים]. That is to say: when

there is before us a globe [יהיה לפנינו כדור] [?] and we wish [?]

to know its thickness — that which is called the diagonal, or the diameter [לדעת עוביו שהוא הנק' אלכסון או קוטר] —

in the language of the sages [כלשון חכמים]: behold, we divide the measure of the circumference of the revolution of that circle into twenty-two parts [הנה] [והקוטר שלו] [נחלק שיעור היקף סיבוב העיגול ההוא אל כ"ב חלקים]

will be the measure of seven parts of those twenty-two [יהיה שיעור ז' חלקים] [?]. And know that when a straight line [ותדע כי כאשר קו ישר] [?] the thickness [עובי] —

of the globe of the earth, from the southern pole to the [northern / lesser] [כדור הארץ מן קוטב הדרומי אל ה' צפוני/קטן] [?] — for this is what is called the diameter of the globe, as above [כי זה נק' קוטר הכדור כנ"ל] — the measure will be [יהיה שיעור] —

¹⁴ רוחב confirmed on CBL's own ink, without the second witness — ר (rounded arc join) · ו · ח (roof on two legs) · ב (open-left C, curled foot, against the ב control from the f. 8v plate, which excludes כ). The second word [מ] · [ט/ע] · [ל] · [כ/ב/ה] survives unresolved: מעלה fits skeleton and context, but no ascender is visible on the third sort and no commitment is made. NLI's compartments are empty, so the second witness is silent.

[numeral: ?] thousand and [numeral: ?] miles [מילין ?], and it is the measure of seven parts of the twenty-two parts of the circumference of the whole globe [והוא שיעור ז' חלקים מן הכ"ב חלקים של היקף כל הכדור],

which was the measure of [numeral: ?] thousand and [numeral: ?] hundred miles [מילין ?], as above [כנ"ל]. And behold, the whole [?] of the settled world, which is [numeral: ?] degrees [כל ?] המיושב שהם [?] מעלות

and [numeral: ?] minutes in all [ונכ"ה ? דקים בכלל], the measure of the [?] will be [numeral: ?] thousand [אלפים ?] [ג' ?] miles [מילין ?] like handbreadths, that is to say [כמו טפחים לאמר] [?]

[?] and thus [numeral: ?] thousand less [?] [וכן וי' ? אלף פחות] [?] and so forth [וכו'] [?] the settlement, every [numeral: ?] miles less [מילין פחות ?] [הישוב כל ד' ?] it emerges that the measure of the circumference [נמצא שיעור היקף]

of the globe is [numeral: ?] thousand miles [אלף מילין ?] [עשרה ?], and therefore [?] wrote [?] the intention as is its way [הכוונה כדרכה] [?]

that he wrote so [שכתב כן]; and the diameter will be [numeral: ?] thousand and [numeral: ?] miles [מיל ?] [אלפים ות' ?] [מיל ?]. And now let us set out the variation in the length of the days in every clime [ועתה נבאר חילוף אורך הימים] [שבכל אקלי']

· Know that the degree beneath which the equinoctial line falls [דע כי המעלה] [?] always [תמיד] [?] as at its beginning so [?], which is called [הנק']

— the days and the nights there are twelve hours [י"ב] [הם ?] [שעות], always [ותמיד] [?] and twelve hours the night [וי"ב שעות הלילה]; and the reason is that the horizon of

that degree is [?] the horizon of the world, as above [אופק העולם כנ"ל]. And in that empty place [ובאותו המקום הפנוי]

whose breadth measures twelve and a half degrees [י"ב מעלות] [אשר שיעור רחבו י"ב מעלות] [היום היותר ארוך אשר שם] [הוא י"ב שעות וחצי] —

and we have already known above [וכבר ידענו למעלה] that, according to the measure of the distance [כי כפי שיעור [ה]חוק] of the degree from the equinoctial line [חוק המעלה מן הקו השווה], so does the pole rise [כך יגבה הקוטב]

— the [northern / lesser] one — for the horizon of that degree [הצפוני של] [?] [וכנגדו] [?] the pole of the southern horizon descends from them [ירד קוטב אופק הדרומי מהם]. And it emerges that,

since the quantity of this empty place [כיון שכמות זה המקום הפנוי] — and they have drawn off [ונתרחקו] twelve and a half degrees from the equinoctial line [כך כמותו] — just so is its like [י"ב מעלות וחצי מהקו השווה]

it emerges that the [northern / lesser] pole stands raised above them twelve degrees [נמצא הקוטב ה[צפון/קטן] גבוה עליהם י"ב מעלות] [ומחצה]. And the first clime, at its beginning [והאקלי' הא' בתחילת] [?] there —

the longest day is thirteen hours [היום היותר ארוך הוא י"ג שעות] [?], and correspondingly the [northern / lesser] pole rose above them twelve

degrees and a half [גבה קוטב ה[[צפון/קטן]] עליהם י"ב מעלות וחצי], and it stood raised above them [numeral: ?] minutes [ונבנה עליהם [?] דקים] [?] their degree, the longest day is thirteen hours [היום היותר ארוך הם י"ג שעות]

and the breadth of the [northern / lesser] [?] is fourteen and a half degrees [והם [?] מילין] [?] the second, above [הב' למעלה] [?] the longest day is [numeral: ?]

hours and a quarter [שעות ורביע], and its pole rose [numeral: ?] degrees [ונגבה קוטבו [עשרה?] מעלות] and a half [וחצי]; and the measure of the whole breadth of this clime is [numeral: ?] [ח'] [?] [ושיעור כל רחב האקלי' הזה הוא ח']

degrees, as above [מעלות כנ"ל], and they are [numeral: ?] miles [והם [?] מילין] [?] the second, above [הב' למעלה] [?] its long day is thirteen and a half hours [יז שעות וחצי]

and the pole rose [numeral: ?] degrees and a half [מעלות] [עשרים?] [ונגבה הקוטב] [?] And at [?] its long day is fourteen hours less a quarter [י"ד שעות] [פחות רביע]

and the pole rose [numeral: ?] degrees and a half [מעלות] [כ"ו?] [ונגבה הקוטב] [?] miles [מילין] [?] The [numeral: ?] clime, above [האקלים ה[ג'] למעלה], its long day

is [numeral: ?] hours [י"ג שעות], and the pole rose [numeral: ?] degrees and a half and a fifth, which are [numeral: ?] minutes [ל' מעלות] [ונגבה הקוטב] [?] [ולתחת י"ד] fourteen [?] [וחצי וחומש שהם מ"ב?] דקים

[Margin: head margin, toward the outer (left) side. Two display sorts stand alone, level with the running header — the folio numeral. The left-hand sort is a squared letter with a horizontal foot running to the right: ב. The right-hand sort carries a stroke that rises above the height of its neighbour and hooks to the left, which on this hand belongs to ל; but a display י set high on the line is not excluded, and I cannot separate the two at the resolution available to me. I therefore record the numeral as [[לב/ב]] and supply no value. No gershayim stands between or above the sorts.]

hours and a quarter, and the pole rose thirty-three degrees and two thirds [שעות ורביע ונגבה הקוטב ל"ג מעלות וב' שלישים] [?] minutes [מ' דקים]; and its breadth is [numeral: ?] miles [ו[רחבו] [?] מיל]

The [numeral: ?] clime, above [האקלים ה[?] למעלה]: its longest day is [numeral: ?] hours and a half [שעות וחצי] [?] [ונגבה הקוטב ל"ז מעלות ושני]

fifths, which are [numeral: ?] minutes [כ"ד דקים] [חומשים שהם כ"ד דקים]; and at its lower end its longest day is fifteen hours less a quarter [י"ה שעות פחות רביע] [?] [ונגבה הקוטב ל]

degrees, and its breadth is [numeral: ?] miles [מעלות ורחבו [?] מיל] [?] The [numeral: ?] clime, above [האקלים ה[?] למעלה]: its longest day is [numeral: ?] hours [י"ז שעות וחצי] [?] [ונגבה הקוטב מ]

degrees and a third, which are [numeral: [?]] minutes [מ' דקים]; and at its lower end its longest day is fifteen hours and a quarter [ולתחתיתו יומו] [?]] [ונגבה הקוטב מ'] [הארוך ט"ו שעות ורביע]

degrees and a half, and its breadth is [numeral: ?] miles [מיל] [?]] [ורחבו] [?]] [מ' דקים]; and at its lower end its longest day is [numeral: ?] hours [שעות] [?]] [הארוך ט"ו שעות וחצי] —

and the pole rose forty-two degrees and two fifths [מ' דקים]; and at its lower end its longest day is [numeral: ?] hours [שעות] [?]] [הארוך ט"ו שעות וחצי] —

less a quarter [פחות רביע], and the pole rose [numeral: [?]] degrees and a quarter [מ' דקים]; and at its lower end its longest day is [numeral: ?] hours [שעות] [?]] [הארוך ט"ו שעות וחצי] —

[numeral: [?]] [מ' דקים]; and at its lower end its longest day is [numeral: ?] hours [שעות] [?]] [הארוך ט"ו שעות וחצי] —

longest is [numeral: [?]] hours and a quarter [מ' דקים]; and at its lower end its longest day is [numeral: ?] hours [שעות] [?]] [הארוך ט"ו שעות וחצי] —

clime adds over its fellow [אקלים ואקלים יוסיף על חבירו] — that its longest day [is longer by] half an hour [כי יומו הארוך חצי שעה]; and [?] that, according to the measure of the distance [רוחק] —

The long days, as in the days of summer [הימים הארוכים כימי הקיץ], will be the long nights in the days of winter [יהיו לילות הארוכות בימי החורף]. And now let us complete the explanation of the matter [ונשלים לבאר ענין]

[?] — only that all the degrees that lie beneath the equinoctial line [רק כי כל] [?] [המערלות אשר תחת קו השווה] [הנה הימים שוים בהם בכל ימות]

of the year — twelve hours the day and twelve hours the night, as above [?] [ולכן אין הפרש בכל המערלות] [?] [השנה י"ב שעות היום וי"ב שעות הלילה כנ"ל]

[?] the variation of [?] or [?] [?] [הרחק מן הקו] [?] — and this depends on the measure of the distance [?] [וזה תלוי כשיעור רוחק]

near to the horizon of the [?] [?] [קרובה אל אופק ה] [?] [מזהותם כנ"ל] — according to what [?] in the whole world, the measure of the hours of the day [שעות היום] [?] [כפי מה ש] [בכל בעולם שיעור שעות היום]

[?] always: the longitude of all the localities is equal, as above [?] [לעולם כל] [?] [אורך המדינות הם שוים כנ"ל] [?] [ויש להם ב' קייצים שהם ניסן ותשרי]

[?] the sun over the people [?] [השמש על האנשים] [?] [ויש להם ב' קייצים שהם ניסן ותשרי] [?] [השמש תמוז ו] [?] [השמש תמוז ו] [?] [השמש תמוז ו] [?] [השמש תמוז ו]

[?] and the whole breadth of the settled place, which is from the equinoctial line [וכל רוחב המקום המיושב שמן קו השווה] as far as [numeral: ?] degrees and [numeral: ?] minutes [עד ס' מעלות ו' דקים], as in all that has been mentioned [ככל הנז']

it is certain that in all the degrees that lie in this place [ודאי שבכל המעלות אשר] they will vary [יש בו יום ולילה] there is in it day and night [במקום הזה] [ישתנו]

according to [?] the latitude of the locality from the equinoctial line, so grows [כפי] [רוחב המדינה מן קו השווה כך יגדל] the length of its day or of its night, as above [אורך יומו או לילו כנ"ל] but [?]

the place [?] the end of the northern horizon [צפון] [סוף אופק] in, in which there is no settlement at all [שאינ בו ישוב כלל], since it is impossible that it should be there entirely day or [לפי שאי אפשר שיהיה שם הכל יום או]

entirely night, as will be explained below [הכל לילה כמו שיתבאר לקמן] · However, in the breadth of [?] the settled place, which is [numeral: ?] degrees and [numeral: ?] minutes [אמנם ברוחב] [המקום המיושב שהם ס' מעלות וכ']

[?] the reason that they have both day and night [טעם היות שיש בהם יום גם] [יש בהם שיעורים]; and what its sense is: for behold, the degrees [ומה ענינו כי הנה המעלות]

that lie in the place which is from the equinoctial line as far as [היושבות במקום] [?] one, twenty-three degrees and [numeral: ?] minutes [כ"ה] [שהוא מן קו השווה עד] [ולא עוד בכלל] [אחד כ"ג מעלות וכ"ה דקים] [?]

— which is the measure of the inclination of the sphere of the zodiac [שהוא] [?] the sun toward the northern side [שיעור נטיית גלגל המזלות] [?] [וגלגל ה] [?] [השמש לפאת צפון], as will be explained below in chapter [?]

[?] [כמו שיתבאר לקמן בפ] and so forth [וכו'] · Behold, the sun revolves directly over their heads [הנה השמש יסוב נוכח ראשם] [?] twice in the year [ב' פעמים בשנה] [?] [הפעם הא']

when the sun goes and draws near to the head of the constellation [?] [כאשר] [?] the inclination [נטיית]. Behold, the tekufah of [הנה תקופת]

[Margin: outer (right) margin — no folio numeral, as expected on a verso. The margin is clean paper as far out as it is covered and carries no gloss. A pale brown blotched mark about the size of two sorts stands in the outer head margin, level with the running header; its strokes are mirrored and it sits clear of both the header and the border rule. It is offset or a stain, not writing of this leaf, and nothing is transcribed from it. The same phenomenon was recorded at the same position on f. IIV.]

Tammuz [תמוז]; and the second time is when the sun turns back [והפעם הב' היא כשחזור השמש] [?] and goes toward the southern side [והולך לצד דרום]. For since those [?]

are near to the equinoctial line [הם קרובות אל קו השווה], it descends [יורד] [?] from the end of the inclination of [מסוף נטיית]

the head of Cancer [ראש סרטן], therefore it revolves directly over their heads twice [לכן יסוב נוכח ראשם ב' פעמים] — once on its outward course and once on its return [אל כל המעלות] As for all the degrees [א' בהלכותו וא' בחזרתו]

that lie [?] over against the end of the inclination of [היושבות] [?] כנגד סוף נטיית] the head of Cancer [ראש סרטן] — and these are the ones distant [?] twenty-three degrees and twenty-five [והם ה'רחוקות] כ"ג מעלות וכ"ה

minutes [דקים] [?] — behold, the sun does not revolve directly over [הנה לא יסוב השמש נכח] their heads at any other time than once in the year only [והנה] [?] when the sun is [?] at the inclination of the head of Cancer [כנטיית ראש סרטן],

which is the day of the tekufah of Tammuz alone [שהוא יום תקופת תמוז בלבד]. And the degrees [והמעלות] [?] which [?] from there [אשר] [?] מכן] — behold, the least of [?] from the inclination of [מנטיית] [?] [הנה מעוט] [?]

the head of Cancer [ראש סרטן], and [?] toward the [northern / lesser] side [וה'צפון/קטן] [?] [וה'דרום/רוב], as far as the completion of [numeral: [פ"ו/ס"ו]] degrees and twenty-five minutes [עד סיום] [ס"ו/פ"ו] מעלות וכ"ה דקים], which is the limit of the settlement [שהוא תכלית הישוב] —

behold [?] the sun does not revolve directly over their heads at all [הנה] [?] [לא יסוב השמש נוכח ראשם לעולם אלא תמיד יהיה השמש] [רחוק מהם]

toward the southern side [לצד דרום]; and everyone who is set further [?] [מהם יותר מחביריהם], so will the distance be from [מן] [כך תהיה ה'רחקה] [?]

the sun [השמש] [?] according to the measure of [?] [כפי שיעור ה'] [?]: as the sun draws near toward the southern side, so it will be drawing away [התקרבות] [השמש לצד דרום כן יהיה מתרחק]

from the [?] [מן] [?], each one according to [?] [כפי] [?]; and therefore in the days of summer, when the sun is nearer to them [שהשמש] [לכן בימי הקיץ] [יותר קרוב אליהם],

the days grow long, and in the days of winter the days grow short [יגדלו] [?] the measure of its distance from them or its nearness to them [שיעור הרחוקו או קירובו אליהם].

And the degrees that are distant from the equinoctial line [והמעלות אשר] [numeral: [ס"ו]] degrees and twenty-five minutes [שהם שיעור] [?] [ס"ו] מעלות וכ"ה דקים], which are the measure of [?]

the distance of the head of Cancer from the [line / pole] [מרחיק ראש סרטן מן] [?] [וה'קו/קוטב] [?] and not [?] [ולא י] — the northern pole stands raised above them [numeral: ?] degrees and [numeral: [כ"ה]] [?] [גבה עליהם קוטב הצפון] [?] [מעלות וכ"ה]

minutes, [numeral: [נ"ב]] [?] [דקים נ"ב כנ"ל], as above [וה'נ"ב] [?]. And we say that there is the point of the end of [שם נקודת סוף] [?] the head of Cancer [ראש סרטן] [?] rises whole [מעלה כולה] [?]

always above their horizon [לעולם מהאופק שלהם], always [לעולם]; and the end of the point of [וסוף נקודת] the head of [numeral: [[נ"ה]]] [ראש נ"ה] over against it, found for them always [כנגד נמצאת להם לעולם] [?]

their horizon [האופק שלהם]; and we say that when the sun is [?] [?] directly [?] like the point of the head of Cancer, one [כמו נקודת ראש סרטן אחת] —

according to the length of the day alone, it will be twenty-four hours [כאורך] day without night [יום בלא לילה] [?], and the rest of the days of the year they are [?] [?] [ושאר ימות השנה הם כ]

hours between the day and the night [שעות בין היום והלילה], except that there is a difference [?] [?] [אלא שיש הפרש ב] between one day and its fellow, as above [בין יום לחבירו כנ"ל]; and when the sun revolves [וכאשר יסוב השמש]

at the end of the point of the head of [numeral: [[נ"ה]]] [ראש נ"ה] — for if the sun, which has passed [כי אם השמש שעבר] altogether [לגמרי], then they will have one long night [ואז תהיה להם לילה א' ארוכה]

out of twenty-four hours, day alone [מן כ"ד שעות בלבד יום]; and the degrees will not [ולא המעלות יהיו] [?] the mean of the motion of the zodiac to their horizon [אמצעי תנועת המזלות לאופק שלהם]

and we say that [numeral: [[ז?]]] degrees rise in a single equalization [ונאמר] [?] one hour [כ?] [שעה א']; as [?] [כי יעלו ז' מעלות בשיווי א'] [numeral: [[ז?]]] degrees set [וכנגד ישקעו ז' מעלות] [?] from the side of

[?] and the degrees will not rise there [ולא יעלו שם המעלות] [?] one [?] [?] the distance, since [?] from the places of the settlement [מהמקומות הישוב], and they will have [ויהיה להם] —

the head of Aries [ראש טלה] [?] and the head of Libra at their [northern / lesser] pole [וראש מאזנים בקוטב [[צפון/קטן]] שלהם], and the head of [וראש]

[?] in it the pole [numeral: ?] degrees and a quarter [בו הקוטב [?] מעלות ורביע] [?] there will be half [יהיה חצי]

[?] upon their horizon [על האופק שלהם], and they will be over against [?] half the year [ויהיו כנגד [?] חצי השנה]

[?] theirs, and they will have [?] from the summer, the whole of it day [ויהיה] [?] —

without night, and [?] from the [?], the whole of it night, without day [בלא] [?] [לילה ו?] [מן ה?] כולו לילה בלא יום] [?] —

[Margin: head margin, toward the outer (left) side of the recto. Two sorts stand alone, level with the running header — the folio numeral. The left-hand sort carries a diagonal stroke descending to the lower left from the baseline, which on this hand belongs to ג; the right-hand sort is a short stroke with a slight leftward turn at the head and no ascender. I read the numeral י"ג = 13. The discrimination that carries it is the descender on the left sort (ג against ד, which has no leg) and the absence of an ascender on the right sort (י against ל). A gershayim-like mark stands between the two sorts but I cannot certify it as separate from the head of the right sort.]

degrees less [?] [מַעְלוֹת פָּחוֹת], every one of the [southern] [?] will be hidden [?] [וְיִהְיֶה נֶעְלָם כָּל הַדְּרוֹמִיִּים], and they will be [?] the whole [year] [?] —

and they will have [numeral: [שְׁנֵי]] months [in summer] entirely day [יום] [וְיִהְיֶה לָהֶם שְׁנֵי חֳדָשִׁים בְּקִיץ] כָּל הַיּוֹם, and [numeral: [ב']] months [in winter] entirely night [לילה] [וְיִהְיֶה לָהֶם ב' חֳדָשִׁים בַּחֹרֶף]; and when [it rises higher] [?] [וְכַשְׁנִגְבִּיהָ]

degrees and [?] [מַעְלוֹת ו'], [?] half of [Taurus] and half of [?] [וְחֲצִי עֶקְרֵב וְחֲצִי דְלִי] will be [hidden] always [נֶעְלָמִים/מַעְלוֹת תָּמִיד], and half of Scorpio and half of [Aquarius] covered [מְכֻסִּים]

[וְיִהְיֶה ג' חֳדָשִׁים כָּל הַיּוֹם] always [לְעוֹלָם]; and there will be three months entirely day [יום] [וְיִהְיֶה לָהֶם ג' חֳדָשִׁים כָּל הַיּוֹם], and [numeral: [ג']] months entirely night [לילה] [וְיִהְיֶה לָהֶם ג' חֳדָשִׁים לַיְלָה]; and when [it rises higher] [numeral: [ע"ז]] degrees and a half, there will be [וְכַשְׁנִגְבִּיהָ? ע"ז] [מַעְלוֹת וְחֲצִי יֵהוּ]

all [?] and [?] [וְכָל?] [hidden] always [נֶעְלָמִים תָּמִיד], and [half] of Scorpio and [half] of [Aquarius] covered [מְכֻסִּים] [וְחֲצִי עֶקְרֵב וְחֲצִי דְלִי]; and there will be four months day and [numeral: [ד']] months [וְיִהְיֶה ד' חֳדָשִׁים] [יום וְלֵיל ד'] חדשים

night [לילה]; and when [it rises higher] [numeral: [פ"ד]] [?] [וְכַשְׁנִגְבִּיהָ? פ"ד] there will be [?] [וְיִהְיֶה?] [?] and half of Virgo [וְחֲצִי מֵאֲזוּנִים וְחֲצִי] [?] and half of Libra and half of [?] [לֵיל וְחֲצִי תוֹלֵה?]

Pisces covered [מְכֻסִּים] [דָּגִים]; and there will be five months day and [numeral: [ה']] months night [לילה] [וְיִהְיֶה ה' חֳדָשִׁים יוֹם וְלֵיל? חֲדָשִׁים] [?] [וְכַשְׁנִגְבִּיהָ? ל'ל] [?] [וְכַשְׁנִגְבִּיהָ? שֵׁם הַקּוּטֵב הַצְפוֹנִי ל'ל] [?] [וְכַשְׁנִגְבִּיהָ?]

degrees, which is the end of the breadth [מַעְלוֹת שֶׁהוּא סוֹף הָרוּחֵב] [?] there they will all be [?] [שֵׁם יֵהוּ כָּל?] — and all the [numeral: [ו']] [southern] degrees [מַעְלוֹת?] [?] [וְכָל?] [מַעְלוֹת הַדְּרוֹמִיִּים]

[numeral: [ו']] [southern] degrees [מַעְלוֹת הַדְּרוֹמִיִּים] [?] [וְיִהְיֶה?] [?] covered [מְכֻסִּים] [?] always [תָּמִיד], and half the equinoctial line of the world will be theirs [וְחֲצִי קוֹ הַשּׁוּא שֶׁל הָעוֹלָם יִהְיֶה לָהֶם]

their horizon and the horizon of the world [קוֹ הָאוֹפֵק שֶׁל הָעוֹלָם] [?] will be [וְיִהְיֶה?] [?]

the summer, when the sun revolves [to the north] [הַצָּפוֹן] [הַקִּיץ שֶׁהַשֶּׁמֶשׁ סוֹבֵב] [?] [וְיִהְיֶה לָהֶם] [?]

that the sun revolves in the south [שֶׁהַשֶּׁמֶשׁ סוֹבֵב בַּדְּרוֹם], they will have [?] [כָּל?] [לילה] [?] [וְיִהְיֶה לָהֶם] [?]

[?] [סָבִיב] [?] [?] [?] [?] [?]

from the degrees which [מִן הַמַּעְלוֹת אֲשֶׁר] [?] [?] the equinoctial line of the world [הַקוֹ הַשּׁוּא שֶׁל הָעוֹלָם]

over them, higher and higher [עֲלִיהֶם מִלְּמַעְלָה לְמַעְלָה]; and in this way it grows [וְכֹזֵה יִגְדֵּל] [?]

inclining toward the northern side always [נוֹטָה לְצַד צָפוֹן לְעוֹלָם]; and the reason is that the [וְהַטָּעַם הוּא לְפִי שֶׁהָ]

[?] that this is the equinoctial line of the sphere of the degrees [הקו] — [?] which is as the middle of the body of the sphere [השוה של גלגל המעלות] [?] as far as [עד] [?]

from the sides, the measure of [?] a breadth of [numeral: [ב'ו/]] degrees [שיעור] [?] toward the northern side, and a breadth of [numeral: [ב'ו/]] degrees toward the southern side [לצד צפון ורוחב] [?] [?] and it is divided [ונחלק]

the breadth, which is a measure of twelve degrees already stated [הרוחב שהוא] [?] the degrees [המעלות] [?] — [?] and [?] [שיעור י"ב מעלות הנז'] [?]

[?] the belt of the degrees and the equinoctial line itself [זור המעלות וקו השווה] [?] as the middle of the breadth of this circuit already stated [ולמעלה] [?] [כאמצע רוחב המע'] [הזו כנז'] [עצמו]

[?] is the circumference of this circle [היקף העגולה הזו], and it is divided into twelve parts [י"ב מעלות] [הקטן] [?] the lesser [ונחלק לי"ב חלקים] [?] and each degree is divided into [numeral: [ל'/?]] [נחלק לנ'] [?]

parts, and each part thirty degrees [חלקים וכל חלק ל' מעלות] [?] [?] twelve [מעלות] [?] — [?] degrees, which is the circumference of the whole of this circle [שהוא היקף כל העגולה הזו]

degrees; and reckon twelve degrees further, its division [ב] [מעלות והחשב י"ב] [?] — [?] degrees of them to one hour [ובכל שעה] [מעלות מהם לא' שעות]

[?] to one third, and every third to one quarter, and so [לא' שלשיות וכל שלש] [?] — [?] proceed and divide up to [?] every measure that [?] and [?] [הלך ותחלק עד] [?] כל שיעור ש[?] וא[?]

the twelve degrees, the ancients [הי"ב מעלות הקדמונים], Taurus rose, etc. [עלה שור וכו'] [?] — [?] you have made [?] a degree, [numeral: [ע"ד/]] [עשית] [?] מעלה [ע"ד/] לפי שאמרת

all the stars that are above the first are at its extremities [כל הככבים שכמעל הא'] [?] — [numeral: [ל'/?]] [?] or [?] and [?] etc. [ל' או] [?] ואו [?] וכו'] [ועד"ז שאר]

the twelve degrees, and when [?] the hour of this sphere [הי"ב מעלות וכש] [?] — [?] above this [?] the degrees, and the measure of the stars [מעל זה] [?] המעלות ושיעור ככבים

[?] fixed [?] fixed at the extremities [קבועים] [?] קבועים בקצות [?] — [?] from [?] and they are [numeral: [ל'/?]] [?] [numeral: [ע"ד/]] [?] at the hour of [והם] [ל"ג] [ע"ד] [?] בשעת

[?] southern of the [?] [?] to descend at the hour of the circuit [דרומי של] [?] — [?] north, and [?] these are called the [?] the fifth, stars [צפון ונ] [הלז נקראים ה] [החמישי ככבים]

[Margin: head margin, toward the outer (left) side of the recto. Two sorts stand alone, level with the running header — the folio numeral, in the same position, the same ink and the same small display size as the preceding leaf's. I read י"ד = 14. The left sort is a top-bar with a stem descending from its right end

— that goes upon his knees, and its stars [numeral: [[כ"א]], the 8th, the Falling Eagle [ההולך על ארכבותיו וככביו [[כ"א]] הח' הנשר הנופל]

and its stars [numeral: [[י']]], the 8th, the [?], and its stars [numeral: [[י"ח]], the 9th, the [?], the [?] — she who sits upon the throne, and her stars [numeral: [[י"ג]], the [?], the [?]] [היושבת על הכסא] [ה[?]] [ה[?]] וככביה [[י"ג]] ה[?]

and the head of the Adversary, and its stars [numeral: [[כ"ו]], the 12th, the [?], and its stars [numeral: [[ש]], the [?]] — he who has in his hand the [?], and its stars [numeral: [[י"ד]], the 13th, [?], the Beast [הי"ג]] וככביו [[י"ד]] ה[?] אשר בידו ה[?] החיה [ה[?]]

and her stars [numeral: [[כ"ג]], the 14th, the [?], and its stars [numeral: [[י"ח]], the [?]] — the [?] and its stars [numeral: [[י"ח]], the 16th, the Flying Eagle, and its stars [הי"ח]] וככביו [[י"ח]] ה[?] הנשר [ה[?]] המעופף וככביו

· [numeral: [[ט]], the 17th, Pisces, and its stars [numeral: [[י']], the 18th, the Serpent the [?] — [?] and its stars [numeral: [?], the [?]] that has wings [ה[?]] בעל הכנפים [ה[?]] וככביו [ה[?]]

and its stars [numeral: [[כ]], the [ordinal: [[כ]], the Bow, which had no [?] — [?] and her stars [numeral: [[כ"ג]], the [ordinal: [[כ"א]], the Triangle, and its stars [numeral: [[ד]], the total of [?] — [?] וככביה [[כ"ג]] ה[?] המשולש וככביו [[ד]] סך

[?] stars — the total of all the [figures] [ה[?]] ורות [ה[?]] — [?] and from [ומן] — the total of all the stars: a thousand and [numeral: [[כ"ב]], and know that the sages [ודע כי החכמים] — [סך כל הככבים אלף ו[[כ"ב]]]

divided it [?] and so many stars have first magnitude [וכ"כ ככבים לו] — [?] and every [וכל] — and every star [?] and large they call of the [?] — [ה[?]] וכל ככב [ה[?]] וגדול יקראוהו מן ה[?]

the first; and those of them that are lesser than these they call [הראשון ומהם] — of the [?] the second, and in this way up to [numeral: [[י']], magnitudes, and it is called [ה[?]] מעלות ונקרא

from the [?] the [?], there are further stars, and [?] [ה[?]] יש עוד ככבים [ה[?]] — [?] and [numeral: [[כ"ח]], and of them [?] [Scribal collation note: [ה[?]] וכ"ח] ומהם [ה[?]] תפל) and [?] [ה[?]] תפל)

[Scribal collation note: [ה[?]] נ"א] and of them, and [?] [numeral: [?]] and [?] dark stars and [?] [ה[?]] וככבים חשוכים ו[?] — [?] to their matter · and know that [?] the [figures] [ה[?]] ורות [ה[?]]

the southern and the northern ones — they are [numeral: [[נ"ב]], divided into [?] [ה[?]] נחלקים לש[?] — [?] degrees along the length of the sphere, from the beginning [?] moving [ה[?]] מתחלת [ה[?]] — [מתנועע]

after the manner of the division of the twelve [constellations] that is in the division, and [?] [ה[?]] כדרך התחלקות הי"ב מ[?] לות שבחלוקה ונ[?] — and you will find that when [?] the sign Aries, part of the [figures] rises [מזל] ותמצא כי כ[?] מזל [ה[?]] טלה יעלה קצת [ה[?]] ורות

מהם [?] צדדהו וכך [?] Taurus, and so forth [?] its sides, and so too [?] — [?] for each one of the twelve [constellations] is divided into [numeral: [ג/]] divisions, and they are called [?] מעלות נחלקין [?] כי כל א' מי"ב מעלות נחלקין [?] חלוקות ונקראים [ל'ג']

faces, and each portion of them [?] ten degrees, and [?] פנים וכל חלק מהם [?] — and you will find that the first ten degrees of every [?] עשרה מעלות ונ [?] ותמצא כי עשר מעלות הראשונות של כל [?]

sign [?] are its first face, and the ten degrees [?] פנים הראשונות שלו והעשר [?] — [?] the second ones [?] are its second face, and the ten [?] שניות [?] — [?] פנים שנים שלו ועשר [?]

last ones [?] are its third face; and behold, as [?] פנים שלישיים שלו [?] — [?] and they will be called, they will be as the first faces, and in this way [?] ויקראו יהיו כפנים הראשונים ועד"ז [?]

as the second faces, and in this way for the rest of the [constellations], and so [?] כפנים השניים ועד"ז כשאר המ"ז/ע לות וכן [?] — [?] כולם [?] כשאר ה"צ ורות הדרומיות [figures] — [?] and northern ones, and all the southern [?] — [?] וצפוניות וכל דרומיות [?] : [?] נמצא מפורשים בפרטות [?] they are found set out in detail [?]

פרק ז

[Rubric: the chapter heading פרק ז' is written in gold, not red, standing at the line-start of line 16 of 28, with the chapter's opening words following it in black on the same line and the terminal : of the preceding chapter above it.]

[?] twelve degrees [?] מעלות [?] — [?] as the beginning of the sphere already mentioned is set, and so forth [?] the matter [?] הגלגל של התחלת [?] ענין [?] והנ' וכו' [?]

the manner of the sun's revolution [numeral: [כ"ב]] [?] אופן סיבוב השמש [?] — [?] degrees. Now although the sphere is round, and every [?] מעלות הנה עם היות שהגלגל הוא עגול וכל [?] [כ"ב]

thing that is round has neither beginning nor end, nevertheless, for the reckoning of the [?] דבר ש[עגול] אין לו ראש וסוף ועכ"ז לחשבון ה[?] — [?] המהלכים של הככבים הוצרכנו [?] ולהתחיל [?]

beginning [?] to take how they vary, and the courses, and not [?] מתחיל [?] — [?] ולכן אמרנו כי ראשיתם הוא מזל טלה ומה [?] ולקחת איך ישתנו והמהלכים ולא [?]

that we have done, and the beginning from Aries and not from its motion, is [?] ששעינו והתחלה מן טלה ולא מתנועתו הוא [?] — [?] קו השווה של המ"ז/ע לות [constellations] [?] הוא לפי שבו פגש [?]

which is called the head of Aries [?] the equinoctial line of the sphere [שהוא] — [?] נקרא ראש טלה [?] השווה של הגלגל [?] as the head of the eastern horizon · [?] כראש אופק המזרחי · [?] שם הקו [?] there the line [?]

the [[tekufah]] of [?], and the day and the night are equal in it, as [?] תקופת
 ש והיום והלילה שוים בו כמו ש — [?] and although the round time itself, which
 begins [?] ועם כי הזמן העגול עצמו אשר מתחיל [?]

to liken the head of Aries to the eastern horizon · in the world [לדמות ראש
[?] [?] הוא [?] החדש [?] [?] it is [?] the new [?] [?] — [טלה כאופק המזרחי · בעולם
of all the times of the year; and behold, at the time of the [tekufah] of Nisan
[?] [?] the head of Aries begins, called [?] to
likens [?] it changes [?] מתחיל [?] לדמות [?] [רא] [?] מתחיל ראש טלה נק[רא]

the eastern one, toward the upper side, at the time of [[midday]] [?] [המזרחי] — [?] [לצד מעלה בעת] [חצות] — [?] in the morning, and [?] its head is called, and it is [?] on the line [?] [בקר ו?] [נקרא] [ראשו והיא] [בקר] —

the equinoctial line of the world [?] all that [?] **קו השווה של העולם [?] כל מה [?]** — [?] its body touches the north of the equinoctial line [?] **גופו הוא נוגע [?]** **לצפון קו השווה**

of the world, as we wrote in [chapter ?], for the equinoctial line [של העולם] — the equinoctial line of the sphere of the [constellations] touches to its north and to its south [השוה של גלגל המזלות] [נוגע לצפון ולדרומו]

[?] to the equinoctial line of the world, and it takes [?] a degree standing
 [[ש]לקו השוה של העולם ולוקח[ה] מעלה עומד] — [?] its head above, like [?] Aries,
 and its feet into [[ת]טלה ורגליו לתוך [?]]

touch more toward the north; and below it, the [lower ones] touch more than both of them toward the north, and [?] the lower ones [נוגעים יותר אל הצפון] [ולמטהו [התחתונים] נוגע ים] יותר משניהם אל הצפון ו[?] התחתונים

is the place of the end and the limit of the inclination of the degrees toward the north side. Three signs are found — $\llbracket \text{?} \rrbracket$ — and they hold $\llbracket \text{?} \rrbracket$ הוא מקום סוף ותכלית נטיית המעלות לצד צפון ונמצאו ג' מזלות $\llbracket \text{?} \rrbracket$ הם מחזיקים

their inclination toward the north; and below, the head of Cancer begins, from the end of the northern inclination, and it turns back and runs toward the side of [ונטייתם אל הצפון ולמטה מתחיל ראש סרטן מסוף נטיית צפון וחוזר ונמשך לצד] the south, and below it [?], and below it [?], and its end [?] Virgo, which is [?] [הדרום ולמטהו] [?] ולמטהו [?] וסופו [ב] תולה הוא [?]

[?] and three signs are found — [[?]] — touching toward the north side; and below, the head of Libra begins [?] ונמצאו ג' מזלות [[?]] נוגעים לצד צפון [?] ולמטה מתחיל ראש מאזניים [?]

[?] the equinoctial line of the world [?] until [?] [[?] קו השווה של העולם עד [?]]
its end toward the south, and below it Scorpio, and below it Sagittarius; and
[[the end of]] Sagittarius is the limit of the southern inclination. And there are
found סופו לצד דרום ולמטהו עקרב ולמטהו קשת ו[[סוף]] קשת הוא תכלית נטיית הדרום
[ונמצאו]

three signs — [[?]] — [?] touching toward the south; and below, the head of [?] begins, from the end of the southern inclination [ג' מזלות [[?]] נוגעים [?] מסוף נטיית הדרום ולמטה מתחיל ראש [?]]

and it runs toward [[Capricorn]], and below it Aquarius, and below it Pisces; and the end of Pisces is found together with the head of Aries [?] the point of the line [ב]נקו' ראש טלה [ב]נקו' ונמשך לצד [גדי] ולמטהו דלי ולמטהו דגים ונמצאו סוף דגים עם ראש טלה [ב]נקו' קו]

of the equinox of the world, like the eastern horizon; and three signs are found, [[?]] [?], touching toward the south [נמצאו] [ג' מזלות [[?]] [?] נוגעים אל הדרום]

and this is their order: [[?]] [?] opposite [[?]], [?] [[?]] northern — that is to say, touching the north of the equinoctial line of [[?]] נגד [?] [?] וזה סדרן [?] [?] צפוניים ר"ל נוגעים לצפון קו השווה של

the world [?] [[?]] [?] eastern [?] and every line of them is [?] [?] of the sphere [העולם [?] [?] מזרחיים [?] וכל קו הם [?] [?] של הכדור]

[not a witness — see Readability] [?]

[not a witness — see Readability] [?]

[?] and all this is at the time of the tekufah of Nisan [?] [?] וכל זה הוא בעת תקופת [?] ניסן]

[?] from the [[?]] : And now — [?] [?] ועתה [?] [?]

[Rubric: the word ועתה is written in gold, at display size, a little above the middle of the leaf. It is not a פרק heading: it stands mid-line, opens a new paragraph in the middle of chapter 7, and its large form hangs down into the line beneath it, which is why that line carries a gap in its middle. This is the fourth gold display item recorded in this codex and the first that is not a chapter rubric.]

the constellations, as has already been [?] ... for the [[?]] [?] המזלות כבר נת[?] ... כי

of the constellations is [?] the [[?]] of the world [?] [[?]] [?] המזלות הוא [?] [?] העולם [?]

the [[poles]], and the equinoctial line of the constellations, and the line of [הקטבים] וקו השווה של המזלות וקו]

the horizons touch; and it is found that at the point[s] of [נמצאו] האופקים נוגעים ונמצא [?] [?] כי בנקודות]

the head of Aries and the head of Libra, which are [ראש טלה וראש מאזנים שהם] מכוונים ממש כנגד [קו] [?] of the line

of the equinox of the world, and there is in them no inclination [השווה של] העולם ואין בהם נטייה]

at all; rather they are set due east and due west [כלל אלא מכוונות במזרח ובמערב]

the equinoctial line of the world, opposite the [[?]] [?] קו השווה של העולם כנגד [?] [?] ה

and the horizons; and below them and above them there is [ו] [ב]אופקים ולמטה [מהם ולמעלה יש]

an inclination of the constellations, either to the north or to the south [נטייה] אל המזלות או לצפון או לדרום]

as I have drawn for you above this. And the point of the head of... [כמו] שציירתי לך למעלה מזה ונקו' ראש

Diagram. A large circle drawn in gold, set into the lower part of f. 15r's text block, with the last thirteen written lines shortened to run down its right-hand side. Two colours only are present: gold for every rule and arc, brown-black for every letter. No red, no blue and no other pigment occurs anywhere in the figure; the red rule at the foot of the leaf is the page's border and is not part of it. The circle spans rather more than a third of the leaf's width, and its centre stands a little below the middle of the leaf.

Drawn on it, so far as the plate carries: a vertical diameter from the top of the circle to the bottom, with a word set outside the circle at each end; a horizontal diameter crossing it at the centre; two curved lines inside the circle, each springing from the top or the bottom of the vertical diameter and running to the centre region — under magnification these are arcs, not chords, and the apparent "chord" in the upper right is the inner one of them rather than a straight line; and a number of straight radii running from the centre out to the circumference, which divide the right-hand half of the figure into sectors. Several sectors carry short marks of one or two sorts with gershayim; these are lettered marks I could not separate and I have not read them as values. The left-hand half of the figure carries fewer rules and one long label set along the inside of its arc.

Label census — read off the plate, in the drawn hand, and nowhere inferred from the body prose:

- מערב (outside the circle, at the top end of the vertical diameter) — west
- מזרח (outside the circle, at the bottom end of the vertical diameter) — east
- קו המזלות (set vertically, reading downward, alongside the upper half of the vertical diameter) — the line of the constellations
- נטי' הדרום (along a rule in the upper-right quadrant) — the southern inclination; the first word carries an abbreviation stroke and is written short
- קו שוה העולם (set along a rule running out to the upper-right circumference) — the equinoctial line of the world
- מזלות / אופק (two short lines together, right-hand side at about the level of the horizontal diameter) — the horizon of the constellations; the second line is four or five sorts opening נקר and I cannot resolve what follows
- לצפון / אופק שוה (two short lines, set at a slant in the lower-right quadrant) — the equinoctial horizon ... to the north
- נטי' (along the inside of the arc at the lower left of the vertical diameter)
- (three short stacked lines of small text inside a sector, upper middle). The first line is two sorts with gershayim and I do not commit it; the second reads מעלות; the third opens ש and is not resolved. See the QA note below.

- [?] (three short stacked lines of small text inside a sector, lower left). The first line is a single sort with a gershey; the rest is not resolved.
- [?] (a four-sort word set on its side, outside the circle at its left). Rotated ninety degrees with respect to the body hand, reading upward.
- Short one- and two-sort marks with gersheyim stand in at least four further sectors of the right half. They are present and I record their presence; I could not separate them and I have read none of them.

[[Cancer]] and the end of Gemini are the limit of the inclination [?] in the north; and the point of the head of [?] and the end of Sagittarius are the limit of the [[inclination]] [[?]] ראש ונקו' בצפון [?] בסוף קשת הם תכלית ה[[נטייה]]

of the inclination in the south. All the remaining degrees of the constellations do have inclination in them; but the inclination of each degree [הנטייה בדרום] ושאר כל מעלות המזלות יש בהם נטייה אלא שנטיית כל מעלה

differs from its fellow; and according to the strength [?] toward the north or toward the south will be the strength of its inclination. And it will be explained [מתחלפת מחבירתה וכפי החוזק אל הצפון או אל הדרום יהיה חוזק נטייתה ונ[[ת]] באר]

now the measure of the inclination of every single degree, the [?] the inclination of the head of [?] [?] toward the north; and the point of the head of [עתה שיעור נטיית כל מעלה ומעלה ה[[?]] נטיית ראש [?] אל הצפון ונקו' ראש]

[?] or the south, as has already been stated above, according as it was [?] — [numeral: ?] degrees, and not [?], according to the opinions of most of the sages [מזלות ולא [?] כפי [[numeral: ?]] או הדרום כבר נת' לעיל כפי שהיה [?] סברות רוב החכמי]

[?] the inclination of the remaining degrees varies [?] in measure [?]; and the reason is that, if the equinoctial line [נטיית שאר המעלות מתחלפות [?] בשיעור [?]] [?] והטעם לפי שאלו קו השווה

of the constellations [?] touching [?] until it should be [?] — like the horizon-line of the world, the degrees would be [כ"ב / כ"כ] נוגעים [?] של המזלות [?] עד שיהיה [?] כדמיון קו האופק של העולם היו המעלות [— see QA]

measured [?] straight from [?] to the south, in the strength of the [?] the horizon-line, and they would be equal in their contact below, since they are [נמדדות [?] ישר מ[[?]] לדרום בחוזק ה[[?]] קו האופק והיו שוות בנגיעתם למטה להיותם]

touching along the diagonal that is drawn [?] — their inclination is not [?] different; for [?] Aries and Taurus and Pisces and Virgo [ל[[?]] אין נטייתם [?] שונה כי [?] טלה ושור ודגים ובתולה

and Libra and Scorpio [?] along the diagonal, from the south toward the north; and there is in them an added inclination, and [?] ומאזנים ועקרב [?]] [?] כאלכסון מן הדרום אל הצפון ויש בהם נטייה יתירה ו

[[Cancer]] and Gemini and [?]. Now the principal part of their inclination is toward the east or toward the west; for their inclination [[?]] ו[[?]] סרטן [[?]] ותאומים ו[[?]] [והנה עיקר רוב נטייתם היא אל המזרח או אל המערב כי נטייתם]

[?] degree [?] of the degrees of the constellations, approximately [?] motions מעלה [?] מש [?] מעלות המזלות בקירוב כ [?] · Now, if its equinoctial line [?] תנועות [?] כפ [?] · והנה אם קו השווה שלו

and that of the constellations stood in line with the equinoctial line of the world — since [?] the sun is fixed upon its own [?] קו השווה ושל המזלות היו ביושר עם קו השווה [?] שלה [?] של העולם כיון ש [?] השמש קבוע בקו השווה

equinoctial line exactly — [it is found] that it always revolved along nothing but the equinoctial line of the world, all the days of its revolution, and did not [?] שלו ממש [נמצא] שתמיד היה מסבב רק קו השווה של העולם כל ימי סיבובו ולא

[incline] right or left at all; and the days and the nights would [not] be equal in all seasons and in all [?], until [?] ימין ושמאל כלל ולא היו הימים והלילות [?] שוות בכל הזמנים ובכל [?] עד

[what] is among the constellations that lie beneath the equinoctial line of the world, in the sphere [?] [?] to be inclined [?] מה [?] שהוא במזלות היושבות תחת קו [?] השווה של העולם בגל' כפ [?] [?] להיות נטוי

north and south, as mentioned; and it has no [?] with the equinoctial line of the world except at the point of the head of Aries and the head [?] לצפון ולדרום [?] כנו' ואין לו [?] עם קו השווה של העולם זולת בנקו' ראש טלה וראש

[?] above. It is found that when [?] the sun is at the point of the head of Aries, at this degree [?] למעלה נמצא כי [?] יות השמש בנקו' ראש טלה כמעלה הלו [?]

[?] — that is the tekufah of Nisan — and it is [set] opposite the equinoctial line of the world; and therefore that day, together with [?] לא הוא תקופת ניסן ולא [?] הוא [מוצב] כנגד קו השווה של העולם ולכן היום ההוא עם

its night, is exactly equal — [numeral: ?] hours and [numeral: ?] hours — in all places and beneath [?]; the sun goes [?] שעות [?] לילו שווה הוא ממש [?] שעות בכל המקומות ותחת [?] הולך השמש [?] ו

one degree [?] of the sphere approximately; and it is found that it inclines a little to the north of the equinoctial line of the world, and does not [?] מעלה אחת [?] של הגלגל בקירוב ונמצא ונטה מעט לצפון קו השווה של העולם ולא

the day is divided from the night by a small amount; and it still goes on [?] day of the month of Nisan, until it is completed, for [?] יתחלק היום מן הלילה דבר [?] מועט ועדיין הולך [?] יום של חדש ניסן עד שנשלם כי

[?] [?] [?] — it stands at the first degree of Taurus. Hence [?] [?] [?] הוא [?] עומד במעלה הראשונה של שור נמצא כי

throughout the month of Nisan it was in the sign of Aries, and the degree from the eastern horizon at the time of its rising was in the sign of [?] בכל חדש [?] היה במזל הטלה והמעלה מן אופק המזרח בעת זריחתה היה במזל

[Aries], each day at one [differing] degree; and thereafter, throughout the month of Iyar, the [?] sign was Taurus [?] מחולקת [?] ולא כ [?] בכל יום במעלה א' [?] בכול חדש אייר היה המזל ה [?] שור

at the time of rising, each day at a [differing] degree, [?] the degrees of Taurus; and in this manner until [?], for after [?] מחולקת [?] בעת הזריחה כל יום במעלה [?] עד אח [?] כי אח

the sign [?] at the time of rising is [?] with the sun; and thereafter it comes round again, one revolution after [?] בעת הזריחה הוא [?] עם השמש ולא"כ [?] חוזר חלילה סיבוב אחר

[another]. And it is found that the further [?] the sun goes, from [?] degree onward the days begin מעלה ואילך ונמצא כי כל אשר יתרחק ה[[?]] השמש מ[[?]] לה] ואילך יתחילו הימים

to draw out further, day after day, until the sun stands at the end of Gemini, which is the end of the [[northern]] inclination [להתרחק יום אחר יום עד שיעמוד
[[השמש לסוף תאומים ש]] הוא [[סוף נטיית ה]] צפון

[?] when it reaches the head of Cancer — that is the longest day of all the days of the year, and [?] [[?]] שבכל ימי השנה ארוך היום היותר [?] לראש סרטן הוא היום היותר ארוך שבכל ימי השנה [?]]

the tekufah of Tammuz. From there onward it comes round again: the sun revolves toward the equinoctial line, and the days — [תקופת תמוז ומשם ואילך חוזר] — [חלילה השמש מסבב לצד קו השווה והימים

grow shorter and shorter, until it reaches the head of [?]; and [?] it revolves at the point of the equinoctial line [[?] ו[[?] מראש עד שיגיע והולכים מתקצרים והולכים

[הוא מסבב בנקו' קו השווה]

of the world, as when it was at the head of Aries; and [?] [[it returns]] to the day and the night being equal, and [?] · [[?]] של העולם כמו בהיותו בראש טלה ו· [[?]] · [[חוזרת]] להיות היום והלילה שוים ו·

that is the tekufah of T[?]. From there onward the sun [?] to move away from the equinoctial line toward the southern side — [ומשם] ת[?] היא תקופת [?]
[– ואילך מת[?] להתרחק השמש מן הקו השווה לצד דרום]

and the days grow shorter by less than [?] degrees, day after day, until it reaches the end of Sagittarius; and it is found [מַעְלוֹת] [?] פחות מתקצרים מעלות מ[?]

[?] but the limit of the southern inclination; and [?] it is the shortest day of the whole year, and [?] [הוא היום היותר] [?] [נה כי אם תכלית הנטייה הדרומית ו] [קצר שבכל השנה ו]

the tekufah of Teves. From there onward the sun returns to revolve and to reach the equinoctial line, day after [תקופת טבת ומשם ואילך חזור השמש לסבב ולהגיע]
[אל הקו השווה יום אחר

day; and the days lengthen little by little, until it reaches the head of Aries as at the first, and [?] it is [כתחילה אל ראש טלה עד שיגיע מעט מעט הימים ומתארכים יום ויום] [?] [?]

exactly opposite the equinoctial line, and that day and that night become equal — [numeral: ?] [numeral: ?] — and [?] it is — כנגד הקו השווה ממש ומשתוים — [?] — ו[?] הוא [numeral: ?] [numeral: ?] היום ההוא והלילה ההוא

the tekufah of Nisan. And this is its [[course]] perpetually, in every year: [numeral: ?] days and a quarter, which is the measure of the solar year תקופת : [ימים ורביע שהוא שיעור שנת החמה : [[numeral: ?]] ניסן וזה דרכו לעולם בכל שנה

פרק ח [CHAPTER 8]

Now that we have explained [?] the preceding [chapter] the matter of the inclination of the degrees from the equinoctial line of [[פרק ח' אחר שביארנו]]

the world; and the matter of the horizon; the revolution of the sun opposite them in [numeral: ?] days; and how [[העולם וענין אופק סיבוב השמש כנגדם]]

the four tekufos come about; and how the cause of the inclination [?] the variation in the measure of the length of the days [?] the nights — שהם ד' [תקופות ואיך סיבת הנטייה [?]] התחלפות שיעור אורך הימים [?]] הלילות

we shall now explain the matter of the inclination just mentioned: how [?] the length and the shortness of the days, and its variation in all the [[regions]]; נבאר עתה ענין הנטייה הנ"ל איך [?]] אורך וקוצר הימים וחילופו בכל ה[[גלילות]] [?]] ול

that we explain the matter of the equinoctial line as the astronomers do — [?] the degree of the degrees, that is to say their rising. Now [?] they were —

equal — the equinoctial line of the degrees and the equinoctial line of the world — and were not inclined one from the other, the degrees would be found [שום קו שוה המעלות וקו שוה של העולם ולא היו נוטים זה מזה נמצאו המעלות]

to be nothing but a straight line, [?] standing one beneath the other, [?] even, degree upon degree; and the measure would be [רק קו ישר ש[[?]] עומדים]]

equal for them. Each sign occupies [numeral: ?] degrees; and it is found that when [?] one sign [?], the [numeral: ?] degrees that are in the sphere [עליהם]] מעלות [[numeral: ?]] מעלות ונמצא כי ב[[?]] מזל א' [[numeral: ?]] שוה כל מזל מקום [שבגלגל]

of the degrees upon the eastern horizon [?] rise [?] with it one part of the [numeral: ?] parts of the equinoctial line of the [[?]] חלק [[י]] קו השוה של גלגל [[numeral: ?]] עולה [[?]] עמו חלק א' מ

daily sphere, [?] which is the measure of [numeral: ?] degrees for each. But since the lines are inclined one from the other, [the degrees] are found [היומי]] מעלות לכל להיות [[?]] הקוים נוטים זה מזה נמצאו [[numeral: ?]] ש[[?]] הוא שיעור

the degrees standing as a diagonal that is [[not]] opposite the equinoctial line of the world; and [?] also that [?] their place [מקום]] מעלות עומדים כאלכסון ש[[אינו]] כנגד]] קו השוה של העולם ו[[?]] גם ש[[?]]

[[when they stand]] on the equinoctial line of the constellations, the measure of every sign being [numeral: ?] degrees — nevertheless, since — [כחיותם]] בקו]]

the degrees and the sun move with the universal motion by way of the daily sphere, one revolution each day [היומי בכל יום סיבוב]]

there its degrees, and in every hour hour according to its own proper measure. These, then, are true hours. שם מעלותיו ובכל שעה הנה שעות אמתיות . . . שעה כתכונתה הנה שעות אמתיות

The sun, in the degrees far to the northern side of the equinoctial line of the daily sphere — the will stand high above them — החמה בלתי לות — הרחוקות לצד צפון קו השווה של גלגל היומי הן קטן/צפון יגבה עליהם

and the southern horizon will lie beneath them, as mentioned above . . . And when the sun draws away toward the northern side, the day will be longer — והאופק הדרומי יהיה תחתם כנ"ל וכשיתרחק השמש לצד צפון/קטן יהיה היום יותר

than the night. Nevertheless there are temporal hours there, as mentioned above; for even when the day there is longer than the night, הלילה ועכ"ז יש שם שעות זמניות כנ"ל כי גם כאשר יש שם היום ארוך מהלילה

and its true hours exceed the true hours of the night — even so, we still say that the day ושעותיו אמתיות יתרות על שעות האמיתיים של הלילה ועכ"ז אנו אומרים כי היום

is twelve temporal hours and the night twelve temporal hours, and day and night are equal in the number of hours; והלילה י"ב שעות זמניות והיום י"ב שעות זמניות שווים בב' מספר השעות

the hours of the day are longer than the hours of the night, and for that reason they are called temporal hours. השעות של היום הם יותר . . . ארוכות מן שעות הלילה ולכן נק' שעות זמניות

And so, when we to reckon the hours of the longest day in that land, they are the twelve hours להעריך י"ב שעות והנה כשנשקף להם הארוך שבכל אותה מדינה הן הם הי"ב שעות

the equinoctial line of the daily sphere — there are differences among them; and therefore that we should set out the differences between them. . . קו השווה של גלגל היומי יש ביניהם שינויים . . . שנבאר השינויים שבהם

that the degrees which lie beneath the equinoctial line — we have already learned that all the days and the nights are equal there — כי המעלות . . . אשר הם תחת קו השווה כבר למדנו כי כל הימים והלילות שווים שם

always, throughout the whole year: twelve hours of day and twelve hours of night. And this is that the sun is displaced תמיד בכל השנה . . . שעות היום וי"ב שעות הלילה וזה שהשמש הוא מתעתק

from them to the north or to the south, since ; and the setting מהם לצפון או לדרום כיון . . . להם היא האופק המרחי . . . והשמש

of the world, the days and the nights are equal in all the lands that are not far from the equinoctial line toward שאינן רחוקות מן הקו השווה לצד

from the north; from the time the days and the nights for them — צפון מעת . . . הימים והלילות להם כי י"ב שעות זמניות של היום אינן שיעור

from the line [[numeral: ?]] מהם [[?]] עלה כל [[?]] דקים מקו השוה ועליית התאומים [[?]] עלה כל [[?]] מהם [[numeral: ?]] דקים מן הקו [[?]] מעלות ו [[numeral: ?]]

of the equinox; and Cancer and Sagittarius — their risings [[?]] are like the risings of Gemini; and [[?]] and [[?]] and Scorpio are like Taurus and Aquarius; and as for Virgo [[?]] ו[[?]] ו[[?]] ועקרב כמו [[?]] שור ודלי וב[[בתולה

and Libra, like [[Aries]] [[?]] and Pisces. And behold, since [[?]] [[?]] of the sphere of the constellations [[?]], there is now a difference in their risings — ומאזנים כמו [[טלה]] ודגים · והנה כיון שנ[[?]] [[?]] עיית גלגל המ[[זע]] לות עתה שינוי עליותם -]

as mentioned above [[?]]. And therefore all the lands [[?]] that lie beneath the equinoctial line are in the [[?]] manner, [[?]] the lands [[?]] that incline [[נ"ל]] [[?]] ולכן כל המ[[דינות]] היושבות תחת קו השוה הם באופן ה[[?]] [[?]] המ[[דינות]] הנוטות

further to the south, or to the [[north]] [[?]], than the measure of the rising of the degrees to the [[north]] [[?]] or to the south — it will change [יותר אל הדרום] או אל ה[[צפון/קטן]] משיעור עליית המעלות אל ה[[צפון/קטן]] או אל הדרום ישתנה

in them [[?]] in another way, [[?]] the difference [[?]] of the risings in each clime בהם ה[[?]] באופן אחר [[?]] שינוי [[?]] אקלים] and you will find [[?]] ה[[?]] העלות שבכל אקלים ה[[?]] [[?]] ותמצא

the remaining climes [[?]], when [[?]] the rising of [[Aries]] [[?]] or Pisces is set against the rising of the equinoctial line of the world — השאר אקלי[[ם]] כאשר -] עליית [[טלה]] או דגים בערך עליית הקו השוה של העולם

they are only [[numeral: ?]] degrees and [[numeral: ?]] minutes of the equinoctial line, against every [[numeral: ?]] degrees of a sign [[?]] or of [[נ"ל]] רק [[numeral: ?]] דקים מן הקו השוה כנגד כל [[?]] מעלות ו [[numeral: ?]] מעלות של [[?]] או של

Pisces. And the rising of Taurus or Aquarius is [[numeral: ?]] degrees and [[numeral: ?]] minutes; and the rising of Gemini or [[?]] is [[?]] דגים ועליית שור] [[?]] דקים ועליית התאומים או [[?]] הם [[?]] מעלות ו [[numeral: ?]] או דלי הם

[[numeral: ?]] degrees and [[numeral: ?]] minutes; and the rising of [[?]] and Sagittarius is [[numeral: ?]] degrees and [[numeral: ?]] minutes; and the rising of Leo [[?]] and Scorpio [[numeral: ?]] מעלות ו [[?]] דקים ועליית ה[[ארי]] ועקרב [[?]] מעלות ו [[numeral: ?]] וקשת הם

[[numeral: ?]] degrees and [[numeral: ?]] minutes; and the rising of Virgo and Libra, [[numeral: ?]] degrees and [[numeral: ?]] minutes. And we find that -] דקים ועליית בתולה ומאזנים [[?]] מעלות ו [[numeral: ?]] דקים ונמצא כי [[?]] מעלות ו

[[?]] [[?]] they are [[?]] [Deletion: one word struck through] the degree and [[?]] [[?]] they are long in rising, and this is [[?]] [[?]] הם [[?]] [[struck]] [[?]] המעלה ומ[[?]] הם ארוכי העליה וזה

in the inclined horizons — that is to say [[?]] [[?]], those far from the equinoctial line; but [[?]] at the horizon of the equinoctial line itself — באופקים הנוטים] -] ר"ל/ז"ל [[?]] הרחוקות מן קו השוה [[אבל]] באופק קו השוה עצמו

the motion of the signs; but the equinoctial line does not revolve [?] so; its portion, its motion; and when there is displaced what has risen [?] תנועת [?] המזלות אבל קו השווה לא סובב [?] כן חלקו תנועתו וכשנעתק מה שנעלה

of the signs, at the beginning of the day, upon what has risen of the equinoctial line, there will be a difference between them; for [?] מן המזלות בתחלת [?] [?] יום על מה שעלה מן הקו השווה יהיה שינוי [?] ביניהם כי

when there have risen from the equinoctial line [numeral: ?] degrees and [numeral: ?] minutes, the whole sign of [Aries] [?] has already risen in the fourth clime [?]; and when there rise [שעלה מקו השווה] [numeral: ?] מעלות [?] דקים כבר עלה כל מזל [טלה] באקלים ה[ד'] וכשעלה [numeral: ?] ו

from the equinoctial line another [numeral: ?] degrees and [numeral: ?] minutes, Taurus too has already risen; and when there rise a further [numeral: ?] degrees [שעלה] מן הקו השווה [numeral: ?] מעלות [?] דקים כבר עלה [מזל] אחרות ו [numeral: ?] מעלות [?] גם שור וכשעלה עוד

and [numeral: ?] minutes, the whole of Gemini has passed; and when there rise a further [numeral: ?] [?] degrees and [numeral: ?] minutes, there has already risen [?] דקים עבר כל התאומים וכשעלה עוד [numeral: ?] מעלות [?] דקים כבר עלה [מזל] מעלות ו

Cancer too; and when there rise a further [numeral: ?] degrees and [numeral: ?] minutes, there has already risen [?] too; and when there rise a further [numeral: ?] degrees [שעלה עוד] [numeral: ?] מעלות ו [numeral: ?] מעלות [?] דקים כבר עלה גם [?] וכשעלה עוד

and [numeral: ?] minutes, the whole of Virgo has passed. And the portions of the equinoctial line are found equal with the [numeral: ?] degrees [?] that from them [?] דקים עבר כל בתולה ונמצאו שוין חלקי קו השווה עם [?] מעלות [?] שמהן [?] מעלות [?] דקים כבר עלה

and Gemini are in one place, set exactly one against the [other]; [?] [?] there is [?] for [?] from them to Gemini — [?] ותאומים הם במקום א' מכוונים זה כנגד — [?] [?] יש [?] כי [?] לתאומים [?] ז[ה] [?] [?] [?] [?]

The reason is that the quantity of Gemini is small [?] the portion of the days; and the quantity from them turned back to diminish and to lessen [הטעם] הוא לפי שכמות התאומים הוא מעט [?] חלק הימים וכמות מהן חזר לפחות ולגרוע

what [?] the quantity of Virgo; and as there rises the whole [?] [?] little, they are the reverse of [?], for [?] [?] כל [?] כמות בתולה וכעולה כל [?] מה שהט[?] כמות בתולה וכעולה כל [?] [?] מעט הם היפך מ[?] כי מ

Diagram. A small drawing, occupying about a fifth of the text-block width, set into the text block at the right (line-opening) edge, occupying the height of two lines — L4 and L5 — whose written measure is correspondingly shortened. What is drawn: a rectangle with three dotted sides and one solid side, crossed by a solid diagonal; its right angle is freehand, measured at 86.3 degrees. Level with L4 stands a further short row of dots with two small marks above them. It is drawn in the body-text pen, not a plate hand, and carries no lettering of any kind.

- No label is legible anywhere in or beside the figure, and none is offered. No letter, numeral or caption stands on it that I can read.

[Librarian note: 18 — modern pencil foliation on the facing side of this leaf; see the f. 18r addendum above.]

[[?]] the day, like the day of each one of them; and the breadth [[?]] degree [[?]] diminishes [?] the day, like the day of each one of them. And we find that מ[[?]]ים היום [[כמיום]] כל א' מהם ורח[[?]] מעל[[ה]] [[?]] פחת היום [[כמיום]] כל א' [מהם ונמצא כי

in the equinoctial line, of the measure of the rising of the signs equal to them, so will the measure of their setting be [[?]] and [[?]] like it [בקו השווה כשיעור עליית] [המזלות כמותם כך יהיה שיעור שקיעתם כ[[?]] ו[[?]] כמוהו

the distant ones, where the day is long, the measure of their rising is not [[?]] [עליית מ[[?]]ים כמותם ונ[[?]] ושיעור [[?]] מ[[?]]ם כ[[?]]ם] [[?]] than the measure of [[?]] [[?]] [רחוקות שהיום ארוך אין שיעור עלייתם] [[?]] מכל שיעור

[[?]] of the measure of the rising of [[?]] equal to them; and [[?]] and the measure of [[?]] [[?]] equal to them, of the measure of the rising [כמע[[?]] שיעור] [עליית מ[[?]]ים כמותם ונ[[?]] ושיעור [[?]] מ[[?]]ם כמותם כשיעור עליית

[[?]] equal to them; and when there is joined the rising [[?]], and there will be of [[?]] with the rising, and there will be of [[?]] the whole equal — [[?]] [כמותם וכשיתחבר עליי[[?]] ויהיה של [[?]] עלה עם עליה ויהיה של [[?]] הכל שווה

And so with the measure with Scorpio and the rest, since there is made [[?]] the reverse [[?]] degree. And now we have taken the [[?]] [וכן כשיעור עם עקרב] [וכי' לפי שנעשית [[?]] הפך [[?]] מעלה · והנה לקחנו עתה ה

that [[?]] from those dwelling beneath the equinoctial line to those dwelling in the fourth clime [?]; and behold [[?]], for [[?]] added [שהו [[?]] מהיושבים תחת קו] [השוה אל היושבים באקלים ה[[ד']] והנה [[?]] כי כ[[?]] הוסיף

[[numeral: ?]] degrees and [[numeral: ?]] minutes, and double it; for the setting too is like the daily setting, of the measure of [[?]]; and behold they are [[numeral: ?]] degrees [[numeral: ?]] מעלות ו[[numeral: ?]] דקים והכפלה לפי שגם [[numeral: ?]] מעלות [[numeral: ?]] כשקיעת יומית כשיעור [[?]] והנה הם

and [[numeral: ?]] minutes. And since this added the arc, as [[?]] rose, the [[?]] remaining will be [[numeral: ?]]. Now the course of the sphere, for [[numeral: ?]] דקים ולפי שהוסיף זה הקשת כמו שעלה ה[[?]] הנשארת יהיו [[numeral: ?]] — [[numeral: ?]] [וכי' לפי שהוסיף זה הקשת כמו שעלה ה[[?]] הנשארת יהיו [[numeral: ?]] — [[numeral: ?]] והנה מהלך הגלגל כי [[numeral: ?]]

degrees are an hour and a fifth, and this is the increase of the day, like [[?]] מעלות הם שעה וחומש וזהו] [[?]] [[?]] [[?]] as the rising of [[numeral: ?]] portions [חלקים [[numeral: ?]] תוס' היום כ[[?]] [[?]] [[?]] כעליית

and [[numeral: ?]] minutes; and double it — they will be [[numeral: ?]] and [[numeral: ?]]. And we find so [[?]] [[?]] rose [[numeral: ?]] and a half, and they are five hours and a third and one portion [דקים ותכפלה יהיו [[numeral: ?]] ו[[numeral: ?]] ש [[numeral: ?]] ו[[numeral: ?]] וחצי והם חמש [[numeral: ?]] ו[[numeral: ?]] ונמצא כן ש [[numeral: ?]] שעות ושליש וחלק א'

degrees, about an hour; and [?] the increase [?] upon [?]. And Gemini added, up to the completion of [numeral: ?] hours and a half, to the measure of [?] מעלו [ת] כשעה ו[?] תוס' [?] על [?] והתאומים הוסיף עד תשלום [?] of [?] שעת וחצי לשיעור [?]

the increase which it added in the fourth clime [?] over the equinoctial line, [?] תוס' אשר [?] on the longest day of the whole year, as mentioned above, [?] [?] הוסיף באקלים ה[ד'] על הקו השווה [?] ביום היותר ארוך שבכל השנה כנ"ל כ

and [?] there shall be subtracted from them as much as the excess of Gemini [?], and there shall be subtracted from them what Taurus added; and there shall be subtracted like [?] יחסר מהן כשיעור יתרון התאומים [?] ים ויחסר מהם [?] ול[?] יחסר מהן כשיעור יתרון התאומים [?] ים ויחסר מהם [?] ויחסר כמו

what [?] added; and we find that [?] and the night have been made equal; and [?] Scorpio shall subtract as much as Taurus added; and there shall subtract [מה שהוסיף [?] ונמצא שנשתוו [?] והל[ילה] ול[?] יחסר עקרב כתוס' שור ויחסר

Sagittarius as much as Gemini added; and it shall add further [?] Sagittarius; and Aquarius shall add as much as Scorpio subtracted; and Pisces shall add [קשת כתוס' התאומים ויוסיף עוד כ[?] [?] קשת ויוסיף דלי כחסרון עקרב ויוסיף] דגים

as much as [?] subtracted; and the day and the night shall return to being equal [?]. And now we shall set out the matter of the hours of the motions [כחסרון מ[?] ויחזור ל[?] שוות היום והל[ילה] · ועתה נבאר ענין שעות התנועות

which is in the fourth clime [?]; and so likewise [?] hours of the motions [?] this; for as the true hours — [?] וככה כיוצא [?] — [שעות התנועות כ[?] זה כי כשעות האמיתיות

The reason, among those dwelling beneath the equinoctial line, is that they are [?] degrees in every hour; but in the remaining climes, when [?] הטעם ביושבים תחת קו השווה הם] מעלות בכל שעה אבל בשאר [?] האקלי' כאשר

the day is divided into twelve hours [?] that they are not [?] hours נחלק היום [?] שעות [נק'] temporal [?] — even so they are called [לי"ב שעות [?] שאינם [?] ות [?] שעות שוות תמיד כ[?] [?] עכ"ז נק' זמניות

for each and every day their measure changes; for behold [?] the days of [?] are [?] than [?] Taurus, and all of them in this manner [כפי כל יום ויום] משתנה שיעורם כי הנה [?] ימי [?] הם [?] מ[?] שור וכולם כזה

And the division of the hours of the motions of Taurus is not like the division of the measure [?] a further temporal hours [?]; and therefore [?] took [?] — [?] ואין חלוק שעות תנועות שור כחלוק שיעור [?] עוד שעות זמניות [?] ולכן]

their measure in the fourth clime [?]; and from them you may infer the rest of the climes. Now the course of one temporal hour [?] שיעורם באקלי' ה[ד'] [?] ומהם תקיש לשאר האקלי' והנה מהלך שעה א' זמנית

the head of [?] they are [numeral: ?] degrees, and from the beginning of Taurus [numeral: ?] [numeral: ?] degrees and a half; and [?] to know the measure of the hour [ר[?] אש [?] הם] מעלות ומתחל [ת] [?] לידע שיעור השעה [?] [?] שור

of each and every day of the days that fall between the head of [[?]] and the head of Taurus, take [[?]] the excess that falls between the head of [[?]] של [[?]] כל יום ויום מן הימים שבין ראש [[?]] לראש שור קח [[?]] היתרון שבין ראש

and the head of Taurus; and behold they are [[numeral: ?]] degrees and a half, which are [[?]] minutes. And we find that on each day of them the increase [[numeral: ?]] וחצי שהם [[numeral: ?]] לראש שור והנה הם מעלה [דקים ונמצא שבכל יום מהם תוספת

of the hour [[numeral: ?]] [[?]]; so nearly, at the head of Gemini, [[numeral: ?]] and [[?]] and a half and an eighth; and at the head of them, [[numeral: ?]] and an eighth [השעה [[numeral: ?]] [[?]] כן יקרוב בראש התאומים [[numeral: ?]] וחצי ושמינית וכבראש מהן

and at the head of [[?]], [[numeral: ?]] and a half, and [[?]] in Gemini [[?]]; and at the head of Virgo, [[numeral: ?]] and a half, like Taurus; and at the head of [[?]] וחצי ו[[?]] בתאומים [[?]] ים ובראש בתולה [[?]] וכבראש [[?]] וחצי כשור ובראש [[?]]

[Foliation: ט"ט — standing in the head margin outboard of the header toward the fore-edge, i.e. to the LEFT of ...ה"ח on this recto.]

Libra, [[numeral: ט"ו]], like [[?]]; and at the head of Scorpio, [[numeral: י"ב]] and [[a half?]]; and at the head of Sagittarius, [[numeral: י"ב]] and three eighths; and at the head of [[?]] — [[numeral: ט"ו]] כ[[?]] לה וכראש עקרב [[numeral: מאזנים]] — [[?]] י"ב]] וג' שמינית וכראש [[numeral: י"ב]] ומ[[חצה?]] וכראש קשת

[[?]] and four[?] eighths; and at the head of Aquarius, [[numeral: י"ב]] and [[numeral: ג']] eighths; and at the head of Pisces, [[numeral: י"ג]] and a half, like Scorpio. And behold — [[?]] וד' שמיניות וכראש דלי [[?]] י"ג]] וחצי כעקרב והנה [[numeral: ג']] שמיניות בקשת וכראש דגים [[numeral: ו]]

[[?]] the matter of the apparent days and the unequal days, for each day differs from another [[?]] the measure, according to — [[נ'נר' ?]] ענין הימים [[?]] הנראים והימים השונים כי כל יום מתחלק זה מזה [[הכ/]] שיעור כפי

the rising of the [[degrees/signs]] [?] each day; for there are degrees [[?]], and [[?]] the risings, and the extremity of the [[degrees]], and all the [[?]] — [[?]] המ[[ע/ז]] לות [[?]] יום כי יש מעלות אחר [[?]] ו[[?]] כי העליות ונקצה המעלות וכל ה

[[?]] of the Sages ז"ל, like the [[?]] days [[?]] — for example, what is written in the tables of the Sun: that — [[?]] משל — [[?]] מה שכתוב בלוחות השמש כי

on one day the Sun travels [[numeral: ט"ט]] minutes and [[?]], for [[?]] — that in every [[numeral: ?]] days it travels [[numeral: ל']] degrees less [[numeral: ?]] נ"ט]] דקים ו[[?]] כי כ[[?]] כי בכל [[numeral: ביום א' הולך השמש]] — [[?]] דקים הוא [[?]] ל' מעלות פחות [[numeral: ?]] ימים הולך [[numeral: ?]]

is according to the unequal days, not according to the apparent days. Also know that the apparent days are according to the risings — [[?]] לא כפי הימים הנראים גם דע כי הימים הנראים הם כפי עליות

the [[?]] course of the Sun; and the equal[?] day travels [[?]] [[?]] is according to the mean course of the Sun. And below — [[?]] של השמש והיום ה[[?]] הולך [[?]] הוא כפי מהלך האמצעי של השמש ולקמן

fixed in its [small/northern] [?] sphere of the epicycle, and the sphere of its revolution [?] — [?] is fixed within the thickness of the breadth of its eccentric carrying sphere; and this — [של הקפה והגלגל] [קטן/צפון] הקפוע בגלגלו ה[?] תו קבוע תוך עובי רוחב גלגלו היוצא הנושא וזה

the sphere. The [?] carrying sphere is [?] the other — [?] another; it too is [inclined?] [?], and the equinoctial line of — [הנושא הוא] [?] [האחר] [?] אחר גם הוא נו[טה?] [?] וקו השווה של

and [?]; and since it has been explained that its epicycle sphere is fixed on the equinoctial line of its eccentric sphere, we find that the star — [וכיון] וחות[?] שנת' שגלגל הקפתו הוא קבוע בקו השווה של גלגלו היוצא נמצא כי ככב

that he wrote [?] revolving [?] like the equinoctial line — [?] its eccentric sphere; we find that the star that he wrote [?] [כמו קו השווה] [?] מסבב [?] שכת' [?] מסבב [?] גל גלגלו היוצא נמצא כי ככב שכת' ב'

the motion of the [signs/degrees] [?], as [?] [?] the Sun [?] — [?] [?] other than it, like the rest of the breadth of the centre [?] [עז/לות] [?] [כמו ש?] [?] השמש [?] מש [?] זולתו כשאר רוחב המרכז זב

not [?], and not outside [?], and in this way [?] — [?] [?], apart from the Sun alone: it has yet a further sphere — [לא/ואז] [?] חוץ מ[?] [?] [ועד?] [?] חוץ מן החמה לבדו עוד יש לו גלגל

greater; the encompassing [sphere] [?], and likewise its sphere [?] — [?] יותר גדול המקיף] — [?] [?] וכן גלגלו ה[?] ק גם [ר/ד] ק גלגל היוצא המשוה המהלך וה[?] נועה

And the matter is that it resembles [?] the sphere of the [signs/degrees] [?], as — [?] its motion, and according to the measure of its course; and therefore only resembles — [תנועתו] [?] [וכשיעור מהלכו ולכן [ר/ד] ק דומה

[?] [?], because it equalizes its course [?] the course of the sphere — [?] [?] ה[?] לפי שמשוה מהלכו [?] מהלך גלגל

The [signs/degrees] [?] [?], and also, since the measure of the parts [?] — [?] [?] whose course, and the sphere revolves [?] ששיעור] [?] וגם לפי ששיעור] [?] [?] הנק [החלקים] [?] אשר מהלך ותסבב הגלגל שכת' [?] הנק

the eccentric sphere, the carrier, the [small/northern] [?] sphere of the epicycle [?] — [?] [?] that their motion is the parts that it travels — [גלגל] היוצא הנושא גלגל ה[קטן/צפון] של ההקפה כ[?] [?] כנג' [?] הם שתנועתם החלקים [שתהלך]

that they should be divided one from another; the [resembling?] sphere, and likewise the eccentric sphere — for it has one [?], eccentric, and [?] the sphere — [?] [?] כי יש לו מו[?] [?] אחד יוצא [?] גלגל

the [signs/degrees] [?], and likewise the motion, since [?] [?], and the line [?] — [?] its equinoctial line, [inclined?] [?], and the equinoctial line of [עז/לות] [?] וכן ה[?] נועה לפי ש[?] [?] וקו ה[?] [?] קו השווה שלו נו[ט]ים מ[?] [?] וקו השווה של

the sphere of the [signs/degrees] [?], like those that [?], resembling in every [?] — [?] the sphere of the [signs/degrees]; and know that this is the [resembling?] sphere [גלגל [?] [?] ומה בכל [?] גלגל] המ[עז] לות כאותן ש[?] ינו [ד/ר] ומה בכל [?] גלגל] המ[עז] לות ודע כי זה גלגל ה[ד/ר] ומה

of [?], it is [?] the sphere which we call — [?] it the sphere [?]; it too, and likewise a globe [?] אותו גלגל] [שכת' הוא ש[?] הגלגל אשר אנו קורא[ים] אותו גלגל] [שכת' גם הוא [?] [?] כדור שכת'

[?] that the epicycle sphere of [?] above [?] — [?] the epicycle sphere of the Moon; they too are [inclined?] — [?] [?] למעלה מ[?] [?] כי גלגל ההקפה של שכת' למעלה מ[?] [?] גלגל ההקפה של לבנה גם הם נו[ט]

[?] [?] hours [?], for the equinoctial line too, and the line — [?] and its [?] are not aligned opposite [?] — [?] [?] וקו [?] שעות [?] כי גם הקו השווה וקו [?] [?] שלו אינם מכוונים כנגד

and the equinoctial line of the [numeral: 1/2] great spheres of [?] — [?] [?] גלגלים הגדולים [numeral: 1/2] וקו השווה של [?] [?] [?] כנגד' והם נו[ט] ים מהם

like those, for [?] the [small/northern] [?] sphere of the epicycle has [?] — [?] two inclinations: the first is what it inclines [?], the inclination of — [?] כאותן כי ל[?] הגלגל ה[קטן/צפון] של ההקפה יש [?] ב' נטיות הא' מה שהוא נוטה [?] [נטיית]

the two eccentric spheres, and [?] the inclination of [?], and more — [?] than the inclination of those spheres. And now we shall explain their matter · ב' גלגלים היוצאים ו[?] נטיית [?] ויותר [?] תר מן נטיית הגלגלים ההם ועתה נבאר ענינם ·]

behold its great [small?] sphere, a globe that [?], and likewise [resembling?] — [?] the equant; behold it is moved from — [?] הגלגל הגדול ה[קטן?] כדור שכת' וכן [ד/ר] ומה [?] המשוה המהלך הנה הוא מתנועע מן

[?] [?], as the measure of the motions of the sphere of the [degrees/signs] — [?] the [degrees/signs]; also the measure of the time of the motion of its course, going — [?] [?] כמדד תנועות גלגל המ[עז] לות [?] מ[עז] לות גם [?] [?] שיעור זמן תנועת מהלכו הולך

like the course of the sphere of the [degrees/signs], that the sphere [?] a star [?] — [?] one complete [revolution] in [numeral: ?] [?] thousand years, so that one degree is found — [?] ככב] כמו מהלך גלגל המ[עז] לות שהגלגל ה[?] ככב] [אלף שנים שנמצא מעלה א' [?] [?] [numeral: ?] א' שלם ב

[?] a year, or according to the view of the Sages, that it is compounded [?] — [numeral: ?] thousand years, one complete [revolution?], so that a degree is found — [?] שנה או כדעת החכמים שמרוכב [?] [?] [סיבוב] א' שלם שנמצא מעלה

one, in every year approximately [?] opposite it, inclined [?] — [?] its [point?], the [small/northern] [?] [?] than [?], its northern [?] — [?] ככל] שנה בקירוב [?] כנגדי נוטים [?] [?] ה[קטן/צפון] [?] מ[?] [?] הצפוני שלו

the sphere of the [degrees/signs], and the southern [?] inclined from the southern [?] of — [?] of the [degrees/signs]; also its equinoctial line

is inclined upon [?] — [?] של [?] מן הדרומי [?] — [?] גלגל המ[עז] לות והדרומי [?] מן הדרומי של [?] — [?] גלגל המ[עז] לות גם קו השווה שלו נוטה על ה

it too goes out [?] the [degrees/signs], and [?] — [?], and it goes out toward the east, opposite the east of the [degrees/signs] — [?] — [?] הוא יוצא [?] — [?] המ[עז] לות ו[?] [?] [?] כן ויוצא לצד מזרח כנגד מזרח המ[עז] לות

straight from the Sun, and it is not [?] nor inclined from [?] — [?] and it goes out toward the east [?], and the second sphere — [?] — [?] ביושר מהשמש ואינו [?] — [?] או [?] מ[?] [?] ויוצא לצד מזרח [?] כת' והגלגל הב'

its [?], which [?] this sphere; behold it is the one called the eccentric sphere — [?] the eccentric, the carrier of [Nogah (Venus)?]; behold its centre, and the inclination of — [?] היוצא הנושא] — [?] הגלגל זה הנה הנק' גלגל היו[?] צא [?] ה[?] הנה מרכזו ונטיית

[?] and its equinoctial line are the [?] in every [?] — [?] [?] the sphere called a globe [?], the equant — [?] גלגל [?] [?] בכל [?] [?] וקו השווה שלו הם ה[?] [?] ככל [?] [?] גלגל [?] [?] שכת' מ[?] שווה המהלך

also the order of its motion is like the first [?] — [?] east[?] for every [?] from it, and according to the measure of the time — [?] גם סדר תנועתו הוא כמו הא' — [?] [?] [?] [?] מזרח? [?] לכל [?] ממנו וכשיעור זמן

its course; behold [?] the sphere, two parts and a second[?] [?] — [?] each day, and [?] [?] accordingly, for [?] the parts — [?] הגלגל ב' — [?] חלקים ו[?] [?] כל יום ו[?] [?] כפי זה כפי כי [?] החלקים

that their course is of the parts of the sphere of the [?], the [?] — [?] the equant, and [?] [?] their motion; and therefore — [?] שמהלך הם מן החלקים של — [?] גלגל ה[?] ה[?] [?] ה[?] השוה המהלך ו[?] [?] תנועתם ולכ[?] [?]

as its own parts; and the [small/northern] [?] sphere of the epicycle is fixed[?] — [?] and its equinoctial line: they resemble the [numeral: א'] spheres — [?] קחלקיו עצמם וגלגל ה[קטן/צפון] של ההקפה [קת/י[ע] [?] וקו השווה שלו] — [?] ג' הגלגלים הם דומים ל

the great ones, which [?]; also the order of their motion [?] — [?] from the [?] [?] [?] in them, for every [?] [?] גם סדר תנועתן [?] [?] בהם לכל [?] [?] [?] מן ה[?] [?] [?]

of them, according to the measure of their course; for [only?] it travels [numeral: ?] minutes [?] — [?] in every day; and [?] the parts are of its own parts, for — [?] דקים [?] [?] ים [?] [?] מהם כשיעור מהלכם כי [ר/ד/ז] ק הולך] — [?] בכל יום ו[?] החלקים הם מחלקיו עצמם כי

This sphere of the epicycle too is itself divided into [?] — [?] into 360 degrees, and each degree into [numeral: ס'] minutes, and each minute into — [?] ש"ס/ש"ם [?] מעלות וכל [numeral: ?] גם זה הגלגל של ההקפה גם הוא נחלק ל[?] [?] ל — [?] [?] דקים וכל דק ל [numeral: ?] מעלה ל

[Layout: f. 19v is written in 28 lines, matching the recto, with the catchword beneath the last line and the foot margin blank below it. A diffuse brown word-shaped stain stands in that blank foot — pale, edgeless, and in the mirror position of the recto's catchword. I record it as show-through and do not read

it. No figure, no ruled table and no marginal gloss stands on either side of this leaf.]

[Variant-reading notes: (א"נ ...) occurrences — f. 19r: o. f. 19v: o. I looked for the round-bracket formula on both sides and found none. The count is given for each side, including the zeros, as required.]

f. 20r

hours, etc. [?] [?] thus the division of all — the great spheres. And so it is found that the three spheres of Shabtai [Saturn] · — [?] [?] כה · [?] שעות וכו' [?] [?] התחלקות כל הגלגל לים הגדולים והנה נמצא כי ג' גלגלי שבת

all of them are moved from the west toward the east [?] — [?] the motion of the outer sphere, since it is [in conjunction / like the conjunction] — [כלם מתנועעים מהמערב למזרח] [?] [?] ועה תנועת הגלגל החיצון כיון שהוא [כ/ב] חיבור

only like the sphere of the degrees; [?] we reckon its course — [?] its course, and that [?] is a very small quantity [?] as has been explained — [ר/קב] כמו [?] [?] גלגל המעלות [?] נו מתחשבים מהלכו וכי [?] דבר מועט מאד [?] כשנתבאר

the three courses of the eccentric sphere, the [?], the carrier — [carr]ier, together with the course of the epicycle sphere; it is found that they are — [ג' המהלכים של גלגל היוצא ה[?] הנו שא עם מהלך גלגל ההקפה נמצא שהם

they are moved each day from the west toward the east, [numeral: ?] min — [numeral: ?] minutes, like the measure of the Sun's course, like the motion of — [ד קים כמו שיעור מהלך השמש [numeral: ?] מתנועעים בכל יום ממערב למזרח] [כתנועת]

according to this; and in the tables which we copied from our teacher the Rabbi, Rabbi [Z]akut, of blessed memory, you will understand from this [?] the combination of these three courses — [ז/ר] כות [?] כפי זה ובלחות שהעתקנו מהר"ר [?] ז"ל תבין מזה [?] חיבור ג' המהלכים האלו

to reckon for each and every planet · Tzedek [Jupiter] too: behold, there is [?] — [?] the sphere of the degrees; behold, below the uppermost sphere [?] לשער בכל ככב וככב · צדק גם הנה יש גל [?] גל [?] המעלות הנה למטה גלגל העליון [?]

the globe of Tzedek, which resembles — its sphere is small [?] — it resembles in all its [particulars] the sphere of the degrees, for behold — [דור] צדק הדומה גלגל שלו [קטן/צפון] [?] ד ומה בכל [פרטיו?] של גלגל המעלות כי הנה

they resemble, likewise, the three small spheres of Shabta — [Shabtai]; these differ according to the measure of their motion; the sphere — [הם דומים] ג"כ אל ג' הגלגלים ה[קטנים] של שבת י[?] אלה משתנים כשיעור תנועתם גלגל

[?] its remainder is [numeral: ?] minutes and [numeral: ?] seconds — each day; and its epicycle sphere is [numeral: ?] minutes each day — [?] שניים ב כל יום וגלגל ההקפה שלו [?] דקים ו [numeral: ?] הנשאר שלו הם [דקים בכל יום [numeral: ?] הם

downward, and with [the line of its inclination?] and its equinoctial line, like the line — [?] and the equinoctial line of the degrees, and [?] — למטה] [?] ועם [?] וקו נטייתו? וקו השווה שלו כמו קו [?] וקו השווה של המעלות

differs from it, for behold, in this it goes out from — [?] a centre other than the centre of [the degrees], and the measure of the distance — משתנה מ[?] — כי הנה לזה הוא יוצא מ[?] מרכז לבד מרכז [הק/מ] מעלות ושיעור מרחק

[?] [?] [?] is two and a half degrees [ב' מעלות וחצי], and [?] — [?] approximately; and the measure of [?] is like the measure of half its [thickness?] — כוז מ[?] [?] הוא ב' מעלות וחצי ו[?] [?] בקירוב ושיעור [?] הוא כשיעור חצי [?] — [?] עוביו

[?] the [position?] of the parts of the resembling sphere, as above; for [?] — כל [?] the thickness of the resembling sphere; there stands the sphere — [?] חלקי גלגל ה[דר/ו] ומה כנ"ל כי כ[?] עובי גלגל ה[דר/ו] ומה שם עומד גלגל

the eccentric, and there it revolves, and [?] the two parts of the sphere — the resembling sphere: the thickness of each of them [כל אחד = כ"א] is equal to the thickness of ha — [?] ב' חלקי גלגל ה[דר/ו] ומה עובי כ"א — [?] מהם שווה כעובי חצי

the other. And likewise · the place of the [thin part?] of the [?], the first — the first, is equal to the place of the thin part of the other [?] — [?] האחר וכן · [?] מקום ה[?] ק של ה[?] הא' שווה למקום הדק של ה[?] האחר ו

[Layout: f. 20r is written in 28 lines and then stops well short of the ruled foot, with the catchword directly beneath L28 and roughly seven blank line-heights of clean paper below it — this codex's documented scribal habit, not a lacuna and not damage. No figure, no ruled table, no inset plate and no marginal gloss stands on this side. A pale, diffuse, word-shaped brown mark stands in the blank foot, at the same height as the catchword but on the opposite side of the leaf. It is edgeless and materially lighter than any ink on the page; I read it as show-through of the verso's catchword and did not read it, and did not use it to check f. 20v's catchword.]

[Variant-reading notes: (א"נ ...) occurrences on f. 20r: o. I looked for the round-bracket formula down both panel columns of all three bands and found none.]

f. 20v

its matter [?] [?]. And now, the body of the Sun is fixed — fixed on the equinoctial line of this eccentric sphere, [?] — ענינו [?] ועתה כוכב השמש] — [?] קבוע בקו השווה של זה הגלגל היוצא [?] מכון

[like / on] the equinoctial line of the degrees, as mentioned; and it is found that [?] — [?] the body of the Sun revolves in a circle [?] the line — [?] קו [?] השווה של המעלות כנו' ונמצא כי [?] כוכב השמש סובב מעגל [?] קו

And behold, it has an epicycle sphere in which the body of the pla— — planet is fixed; and this small sphere is set into the sphere [?] — והנה יש לו גלגל [?]] ההקפה אשר בו קבוע עצם הכ כב וזה הגלגל ה[קטן/צפון] מורכב בגלגל

the great one among them is the one called the eccentric sphere, the carrier and the inclined, and [?] — [?] and above it the carrying sphere, and it is not eccentric; and above it the sphere — גדול שבו הוא הנק' גלגל היוצא הנושא והנוטה [?] ועליו וגלגל הנושא ואינו יוצא ועליו וגלגל

the uppermost, called the globe of the planet; and within it the resembling sphere, and [?] — and it differs; [?] shows you; and the eccentric and the inclined. And this is the order of — [העליון הנק' כדור ככב ותוך גלגל ה[דר/ו]מה ומ] — [שונה ה[?]] לך והיוצא והנוטה וזה סדר

its motion and its time. And the uppermost sphere, called the globe of the planet — behold, it resembles the globe of Shabtai [Saturn] in all its particulars; and the sphere — [תנועתו וזמנו וגלגל העליון הנק' כדור ככב הנה דומה אל כדור שבתי בכל] [פרטיו וגלגל]

the third, which is within it, is called the carrying sphere, and it is not eccentric, and [?] — [?] is moved [in the opposite direction?] from its globe, from below upward — [מתנועע] [?] [?] ויצאו גלגל הנושא ואינו [?] [?] להפך? מכדורו מ?] למעלה

[[numeral: נ"ט]] minutes each day, like the Sun, and revolving with it — with it, the third sphere within it, called the eccentric and the carrier — [[numeral: נ"ט]] דקים בכל יום כמו השמש ומ[[וסבב?]] ע' מו גלגל הג' שבתוכו הנק' היוצא [[והנושא]]

and the inclined; the motion of the planets [is the opposite of?] their motion [?] — [?] from [?] upward, like its motion; and by means of its revolution — [והנוטה תנועת הכוכבים [הפך?] תנועתו [?] [?] מ[?] למעלה כתנועתו וע"י סיבובו]

the third sphere within it, called the eccentric, the carrier, the inclined — [[?]] is moved; their motion, the [[?]], the [[small]] one, is continual — [גלגל הג']
[שבתוכו הנק' היצא הנושא הנוטה ה[[?]] מתנועע תנועתו ה[[?]] ה[קטן/צפון] תמידית

it is moved [?] each day one degree [מַעְלָה א'] and [numeral: נ"ח / נ"ט ?] min — — utes [?] degrees and parts of its uppermost[?] sphere, the one called — [בכל יום מַעְלָה א' ו] [?] מתנוועע [numeral: של מעלות וחלקים ד קים מ ?] [נ"ח/נ"ט ?] גלגלו ה[עליון ?] הנק'

the globe of the planet, [?] the above, [in / the] sphere that [?]; and behold, since — since the [inclined] sphere revolves it, the [small] one, [?] from — כדור ככב [?] ה"ל [ב/ה] גלגל שכת' והנה כיון שהגלגל ה[נוטה/נועה] מסבבו ה[קטן/צפון] מ [?] [?]

upward, $\llbracket ? \rrbracket$ $\llbracket ? \rrbracket$ in length and in breadth; the motion $\llbracket ? \rrbracket - \llbracket ? \rrbracket$ that $\llbracket ? \rrbracket$ is moved; this is the $\llbracket \text{forward?} \rrbracket$ one — $\llbracket ? \rrbracket$ $\llbracket ? \rrbracket$ למעלה כן ולרוחב התנועה] ה[היא מתנועעת] זוהי קדמית

and the motion of this sphere is found — the eccentric, the carrier, the [?] — [?] its course, the [?]; they are moved [?], it is moved — [וּנְמָצָא תְנוּעָתָהּ] [הַגִּלְגָּל הַיּוֹצֵא הַנוֹשֵׂא הַ?] [הַ?] [מֵהֶלְכוֹ הַ?] [מִתְנוּעֵי] [מִתְנוּעֵי]

[[?]] each day [[numeral: נ"ט]] minutes, like the Sun; and it is found — and it is found that it completes [[numeral: א']] revolution in a year, like the Sun — [[?]] א' [[numeral: נ"ט]] דקים כמו השמש ונמצא שמקיף סיבוב בכל יום [[?]] בשנה כמו השמש]

[[?]] before [[?]], it is found to complete two revolutions [ב' סיבובים] — its revolution in a year, since its course each day is double — [[?]] נמצא [[?]] מסבב ב' סיבובים [[סי]]בובו בשנה לפי שמהלכו בכל יום כפלים

[Layout: f. 20v is written in 28 lines and then stops well short of the ruled foot, matching the recto: the catchword sits directly beneath L28 and roughly seven blank line-heights of clean paper follow. No figure, no ruled table, no inset plate and no marginal gloss stands on this side. A pale, diffuse, edgeless brown mark stands in the blank foot, at the mirror of the recto's catchword position and at the same height; I read it as show-through and did not transcribe it. Two small round brown spots stand near the outer edge of the written block, one above the other — foxing, clear of the text, obscuring nothing.]

[Variant-reading notes: (א"נ ...) occurrences on f. 20v: o. No round-bracket variant formula stands anywhere on this side.]

f. 2IR

[Foliation: כא — two sorts, black, display size, in the outer (LEFT) head margin. No geresh and no gershayim. As a numeral כא" = 2I.]

the course of the Sun; the epicycle mounted upon the eccentric, the carrier, the inclined sphere already mentioned — [[?]] — [[?]] על גלגל היוצא הנושא הנוטה הנו' מהלך השמש גלגל ההקפה המורכב

each day it is moved [[?]] [[numeral: ג']] degrees and [[numeral: ?]] and twenty-four hours [כ"ד שעות] '' | the Moon [[differs?]] from all the star[s] — וכ"ד שעות " | לבנה [[?]] מעלות ו [[numeral: ?]] מכל הככבי[[ם]]

its uppermost sphere, called the globe of the Moon, and called the sphere resembling the sphere of the degrees in all its particulars, as was explained — [גלגלה העליון הנק' כדור הלבנה ונק' גלגל הדומה בכל פרטיו לגלגל המעלות כמו שנתב']

as above, like the globe of the Sun; and within it the second sphere, called the sphere of the [[?]] serpent, and it too resembles the sphere of the degrees in all its particulars — [כנ"ל כדור חמה ובתוכו גלגל הב' הנק' גלגל נחש [[כהה]] ודומה בכל] פרטיו לגלגל המעלות

except in [[?]] [[?]] [[?]] like the motion of the second; and so the measure of its motion is [[?]], and its course — [[?]] [[?]] [[?]] תנועת הב' הנה] כשיעור תנועתו [[כמעשיות?]] והמהלך שלו

[[?]] the course of the [[Dragon / the Teli ?]] [[?]] [[?]], since within it there is another sphere [[moving?]] [[?]]; and since it is — [[?]] [[?]] [[תנין/תלי?]] מהלך ה' לפי שיש בתוכו גלגל אחר [[נועה?]] [[כמעשיות?]] והנה להיותו

[[?]] [[its motion?]] [[held back?]], called [[the]] equinoctial line of the sphere of the [[?]] serpent, the carrier, from the line of the inclined sphere — [[?]] [[תנועתו?]] [[מעוכבת?]] הנק' ש[[קו השווה של גלגל נחש]] כהה?]] הנושא מקו הגלגל הנוטה]] which is within it; they join [[?]] at two opposite points [ב' נקודות נכחיות], called the head of the Teli and the tail of the Teli, and [[?]] — שבתוכו יתחברו] — על ב' נקודות נכחיות הנק' ראש התלי וזנב התלי ו

of the Teli, which [[?]] [[?]] [[its circle?]] [[?]] another, and the tail of the Teli, which as it moves is long, and as [[?]] — [[עגולתו?]] [[?]] של התלי אשר [[?]] אחר וזנב התלי שכמתנועע ארוך וכמו ש[[?]] כפ

regarding the sphere of the degrees: for any two spheres one inside the other whose poles coincide, their lines too are the equal ones — [כל ב' גלגלים זה בתוך זה אשר קוטביהם שוים גם קויהם השוים בענין גלגל המעלות כי]

they are equal one to another; but if their poles are not equal, their lines too [[?]] from this, and there are not two lines [[?]] two — [[?]] אם השוים זה כזה אבל אם אין קוטביהם שוים גם קויהם [[?]] מזה ואין ב' קוי' ב'

the spheres rub against one another except at two points [ב' נקודות] and it is called [[?]] [[?]] the distanced one, which [[?]] — [[זולתי בב' נקודות]] ונק' [[?]] המורחק ש

Diagram. Two circles drawn in gold, of nearly equal radius and set eccentric to one another: one is displaced upward and to the left of the other, so that the two arcs cross near the left of the figure (about the 9 o'clock position) and again near the right (about 3 o'clock), and stand farthest apart at the top and at the bottom, enclosing a crescent-shaped space above and another below. Nothing else is drawn — no diameter, no chord, no radius, no pole marks and no third circle. A single small black dot stands near the middle of the inner circle; it is not joined to anything.

Labels, all in black ink at a size between the body hand and the running header:

- top (horizontal, inside the upper crescent, between the two arcs): תנין [?] — four sorts, the last descending below the line
- bottom (horizontal, inside the lower crescent, between the two arcs): the same four-sort form, תנין [?]
- left, outer (set vertically, rotated, outside the outer arc at the left crossing): not read — five sorts
- left, inner (set vertically, just inside the left crossing): זנב [recte: זנב] — three sorts, settled (Adjudication B, Locus 8); see the QA note below. [Superseded: "not read — three or four sorts".]
- right, inner (set vertically, on the arc at the right crossing): not read — THREE sorts (the earlier "about four" is resolved to three by component analysis). ראש is consistent with all three and is NOT adopted; see the QA note below.
- right, outer (set vertically, outside the arcs at the right crossing): not read — five or six sorts

[[?]] and [[?]] the matter of the [[globe?]] [[?]] the third sphere, called the inclined sphere; [[?]] is not [[?]] — [[?]] גלגל הג' [[?]] ענין ה' כדור?]] ו' [[כמעשיות?]] הנק' גלגל הנוטה [[?]] אינו ונראה

[Gloss: three lines in a second hand in the outer (LEFT) margin of f. 21r, beside body lines L1–L5. Not read. Ink and ductus both differ from the scribe's: the gloss ink is a grey-brown, distinctly lighter and warmer than the body's dense black, and the letters are larger, more widely spaced and more loosely formed, with longer descenders — clearly a different hand, not the scribe adding to his own page. No ink of it runs off a panel edge (see the substrate note above). No word-level reading was attempted.]

[Layout: f. 21r is written in 28 lines and then stops well short of the ruled foot, with the catchword directly beneath L28 and roughly seven blank line-heights of clean paper below. The figure is set into the writing block on the left, so L13–L21 are shortened on the left and run around it — a ragged measure by design. A small round hole stands in the outer head margin, clear of all text.]

[Variant-reading notes: (א' נ"א ...) in round brackets on f. 21r: o. No round-bracket variant formula stands anywhere on this side.]

f. 2IV

[[?]] and the measure of the inclination of its equinoctial line from the line of [[?]] the degrees — they are [[numeral: ?]] degrees to the south — [[מולכן?]] [[מעלות לדרום ?]] ושיעור נטיית קו השווה שלו מקו [[?]] המעלות הם

[[at]] the head of the line, and [[numeral: ?]] degrees to the [[north / small ?]], at the beginning of the line; also its poles are moved [[numeral: ?]] degrees from the line [[?]] — [[כ?]] ראש הקו ו' — [[מעלות ל' צפון/קטן?]] כתחלת הקו [[?]] [[numeral: ?]] גם קוטביה נועים

the degrees; and within it the fourth sphere, called the eccentric and the carrier and the inclined; and the measure of its inclination is like the measure of — [[המעלות ובתוכו גלגל הד' הנק' היוצא והנושא ונוטה ושיעור נטייתו כשיעור]]

the inclination of the third sphere; and the measure of the knowledge of its centre [[?]] is [[numeral: ?]] degrees and a [[third / three?]] approximately, toward the side of — [[הוא]] [[?]] מרכזו [[?]] ו' — [[מעלות ו' שלישי/שליש?]] בקירוב לצד

the distance of the centre of the [[Earth?]]; the small sphere of the epicycle of the Moon is mounted in the fourth sphere, called — [[הקטן של ההקפה של הלבנה מורכב בגלגל הד' הנק' מרחק מרכזו ה' ארץ?]] גלגל]

the eccentric and the carrier and the inclined, as mentioned, [[?]] its own; and the globe of the Moon itself is fixed on the equinoctial line — [[הנוטה כנ']] שלו וככב הלבנה עצמה תקוע בקו השווה

of the epicycle. And behold, above, like the matter of the epicycle of Shabtai [[Saturn]] [[?]], for the sphere — [[של גלגל ההקפה והנה למעלה כענין גלגל ההקפה של]] שבתאי [[?]] כי גלגל

the epicycle of every star [?] the stars that are above [?] its second, and two inclinations: the first inclination is the matter of — [?] כל ככב מ[?] — [?] ככבים שלמעלה [?] ב' שלו וב' נטיות נטייה א' היא ענין

its inclination from the sphere of the degrees, on account of the inclination of its great [moving / inclined ?] sphere; and the second is the inclination of — [נטייתה מגלגל המעלות מחמת נטיית גלגלו ה[נועה/נוטה] הגדול והב' הוא נטיית]

itself, greater than the measure of the inclination of its great [moving / inclined ?] sphere. · And [to conclude?]: the epicycle of — [עצמה יותר משיעור] — [נטיית גלגלו הגדול ה[נועה/נוטה] · ו[לחתום?] גלגל ההקפה של

the Moon change in this way, unlike all the other epicyclic spheres; for it has no other inclination, but its inclination — [הלבנה משתנות כזה מכל שאר גלגלי] — [ההקפה כי אין לה נטייה אחרת אבל נטייתה]

is not like the inclination of its uppermost sphere, the eccentric, the carrier [and the] [moving one?]; it too changes from them, a change — [אינה כנטיית] — [גלגלה העליון היוצא הנושא [וה] [נועה?] גם היא משתנות מהם שינוי]

another. And behold, according to the order of their motion [?], and in another [?] the reason for the [numeral: ?' ?] spheres of the Moon mentioned, called — [ה' ?] [numeral: ?] אחר והנה כסדר תנועתם [כמעשיות?] ובאחר [?] טעם ה[?] — [גלגלים הנו' של הלבנה הנק']

the first resembling sphere: it has already been explained that it resembles the sphere of the degrees in all its [reasons / particulars ?]; and the second sphere — [גלגל הדומה הראשון כבר נת' שדומה לגלגל המעלות בכל [טעמיו/פרטיו?] וגלגל הב']

which is within it, called the sphere of the [?] serpent: it too resembles it in all its particulars, [?] the sphere of the degrees, [?] according to — [הנק' גלגל נחש [כהה?] גם הוא דומה בכל פרטיו לגלגל המעלות [חולק?] כפי]

its motion, and like the measure of its motion; for behold, the line [?] is moved with a contrary motion [תנועה הפכיית] from the [depth?] [?] — [תנועתו] [?] [וכשיעור תנועתו כי הנה קו [?] מתנועע תנועה הפכיית מן ה[מעמק]

the degrees; and the measure of its motion is [numeral: ?' ?] chalakim and [numeral: ?' ?] seconds approximately each day, which [?] [?] — [המעלות] [?] [?] [שניות בקירוב בכל יום ש [numeral: ?] חלקים ו [numeral: ?] ושיעור תנועתו [?]]

completes once in 18 [י"ח] [recte: ?] years and [numeral: ?] months and [?] a day and a half; and this course is called the course of the [Dragon?], and [?] [?] — [חדשים ו?] יום וחצי וזה המהלך [?] [?] שלם פעם א' בי"ח שנים ו] — [?] ו[?] נק' מהלך ה[תנין?] ו

for this sphere is mounted in its fourth sphere, [called] the eccentric, the carrier, and [?] its motion — [הנושא ו?] תנועתה] — [הנושא ו?] תנועתה]

the [?] spherical [?], according to its shape, and from the [depth?] upward [?] · the third sphere within it, called the [moving / inclined ?] sphere — [ה?] ית הכדוריית כתמונתו ומן ה[מעמק?] למעלה [?] · גלגל הג' שבתוכו הנק' גלגל] — [ה[נועה/נוטה]]

and it is not eccentric; it too, its motion is like the motion of the sphere of the [[?]] serpent — their shape above, [[numeral: ?]] degrees — [ואינו יוצא גם הוא] מעלות [[?]] תנועתו כתנועת גלגל נחש [[כהה?]] תמונתם למעלה

and [[numeral: ?]] chalakim [[and]] degrees, and in chalakim of the sphere of the degrees; and it revolves [[?]] the fourth sphere, the eccentric, toward the side of — [[?]] חלקים [[ו]] מעלות ובחלקים גלגל המעלות ומסבב [[?]] לגלגל [[numeral: ?]] — [הד' היוצא לצד

[[always?]] the opposite of its true motion [[?]], and it revolves [[?]] a star, also toward the epicycle, to the east; and when you add — [[תמיד?]] הפך תנועתו]] האמתית [[?]] ויסבב [[?]] ככב גם לגלגל ההקפה לצד מזרח וכשתחבר

the two [[?]] of the [[?]] serpent and of the [[inclined?]], which are both of them [[?]] above, there remain [[numeral: ?]] — [[?]] ב' ה' של נחש [[כהה?]] ושל]] [[?]] א' [[numeral: ?]] ה' נוסה?]] אשר שתיהן [[?]] למעלה נשאר

[[numeral: ?]] degrees and [[numeral: ?]] minutes and [[numeral: ?]] seconds each day. · The fourth sphere within it, and the eccentric, the carrier, the [[?]] — [[numeral: ?]] דקים ו מעלות ו [[?]] — [[?]] שניות [[numeral: ?]] נ"ב?]] דקים ו מעלות ו [[?]] — [[?]] בכל יום · גלגל הד' שבתוכו וגלגל היוצא הנושא ה

the [[inclined?]] is moved with its true motion, the [[?]]; [[?]] the minutes, moved eastward each day [[numeral: ?]] — [[?]] כ"ד?]] ה' נוסה?]] מתנועת תנועתו האמתית]] [[?]] כ"ד?]] הדקות מתנועע למזרח בכל יום

degrees and [[numeral: ?]] chalakim approximately; and these degrees and the chalakim are reckoned from the chalakim of the sphere — [[?]] מעלות ו]] [[?]] חלקים בקירוב ואלו המעלות והחלקים הם נחשבים מחלקי הגלגל

its [[inclined?]] third, upon [[?]] [[?]] in the sphere [[?]], and [[?]] and Kochav [Mercury] and the remaining stars; and behold, when you subtract — [[?]] נוסה?]] שלה הג' על [[?]] [[?]] בגלגל ש' [[?]] ו' [[?]] וככב ושאר הככבים והנה כשתגרע

[Layout: f. 2IV is written in 28 lines and then stops well short of the ruled foot, matching the recto: the catchword sits beneath L28 and roughly seven blank line-heights of clean paper follow. No figure, no ruled table and no marginal gloss stands on this side. A pale, diffuse, edgeless brown mark stands in the blank foot, at the mirror of the recto's catchword position — read as show-through, not transcribed. The recto's two gold circles show through onto this side as faint closed curves crossing the middle band, together with one pale grey vertical mark in the mirror position of one of the figure's side labels; none of it was read as a second figure or as a second label.

[Variant-reading notes: (נ"א ...) in round brackets on f. 2IV: o. No round-bracket variant formula stands anywhere on this side. Two bare נ"א tokens do stand, at L17 and L25, both inside sexagesimal runs (ג' חלקים ונ"א שניות), (נ"ב דקים ונ"א שניות) and neither in brackets; I have read them as the numeral 51 rather than as the collation marker, and flagged them as numerals accordingly. The two stand only eight lines apart in parallel positions, which is exactly the configuration in which one reading gets copied onto the other, so neither is committed.]

f. 22r (source PDF p. 43)

[Margin: foliation כב — two sorts, medial kaf + bet, no geresh, head margin at the outer (left) side, left of the running header.]

the motion of the two spheres that [?] in them, and of the motion whose motions are upward; and they are 11 and 12 minutes [י"א וי"ב דקים — both numerals flagged]. ... from us; and now this bearing eccentric sphere, whose motion [?] is 24 degrees and 22 minutes [כ"ד מעלות וכ"ב דקים] ... 13 degrees and 11 parts approximately [י"ג מעלות וי"א חלקים בקירוב]. The epicycle sphere's motion each day is [?smaller / ?northward — צפון/קטן do not separate here] than [that of] the eccentric. And the motion of the inclined [sphere] [?] westward is 12 degrees and 30 parts approximately [י"ב מעלות ול' חלקים בקירוב] each day, [?] the epicycle sphere, [?].

Now when you subtract the mean course of Chamah [the Sun], which is [?] ... [?] hours, from the mean course of the eccentric sphere of Levanah [the Moon], which is 12 [?13] degrees [י"ב מע'], as noted, there remains the mean course of Levanah: 12 degrees and 11 minutes and a half [י"ב מעלות וי"א דקים וחצי]. And when you [?] 24 degrees and 22 minutes [כ"ד מעלות וכ"ב דקים], which is the course of the eccentric sphere of Levanah, and [?] that the eccentric sphere of [Levanah] moves by the measure of double its distance from Chamah. So it has come to light that its eccentric sphere makes two revolutions in each month of the twelve months of Levanah. [Line largely unresolved: ואז/ולא [?] ... מעלי יסוד התנועה [?] כתבי מעש' ...]

[?] is rejected, since Levanah has no resembling sphere [גלגל הדומה] called the globe of Levanah; rather its [?upper] sphere [גלגל ה'] is [?] the sphere [?], and that is the one called its resembling sphere. And likewise, since we [?posited] above [?], [?] that there is no [?]. Levanah [?comprises] three great spheres and one epicycle sphere.

פרק י'

[Chapter 10 — the rubric פרק is written in gold; the numeral is a single sort carrying a mark above it, read as yod with a geresh.]

On the explanation of the [?] of the small spheres, in whose midst the earth is not, and [?] — [line-filler dash at the end of the line]. And their [?configuration]: each one of them encompasses [something] and revolves around the earth, while the earth is not within it, as noted. [?] the epicycle sphere, in which the bodies of the planets are fixed, as above; and they exist in all [?five / ?seven] of the planets [ה' ככבים] [?], apart from Chamah. [?] that the epicycle sphere is a sphere [?] very small [?], whose every revolution of the globe of its sphere is of the measure of the thickness of the great sphere that encompasses it and [?] the world; and the world [?]. And this sphere, in which the epicycle sphere is set, is the one called the bearing eccentric sphere, which is the [?innermost / ?most natural] of all the spheres of that planet.

The epicycle sphere is placed and fixed within its thickness, upon the wall [דופן] of the eccentric sphere. As if you were to say: at the place of the equinoctial line [הקו השווה] of the eccentric sphere there is a hole, and one [?round] window, of the thickness of the wall of the sphere, at the place where its equinoctial line is; [?] as [?] one part of it; and that hole revolves through the whole of that thickness.

Diagram. A set of concentric circles drawn entirely in gold, occupying the lower half of the written area, left of centre; the surrounding text lines are shortened and run around it on the right, so the measure is ragged there — layout, not damage. There is no red and no blue anywhere in the figure; every ruled line and every circle is gold, and every label is in the scribe's black ink.

Construction, stroke by stroke, as drawn: a large outer circle; within it a second, intermediate circle concentric with it; within that a small circle; and at the exact centre a very small ring. A horizontal diameter in gold runs the full width of the outer circle through the centre, and a vertical diameter in gold runs the full height through the centre. Set on the vertical diameter, in the upper part of the figure, is a further small circle drawn about the upper intersection region, itself crossed by a short horizontal chord in gold; that small circle's horizontal chord terminates at two marked points, and its lower pole sits at a marked point on the vertical diameter. Small gold ring-marks are drawn where the diameters meet the circles and at the ends of the short chord.

Labels read, by position:

- א (apex of the figure, at the top of the vertical diameter, immediately above the small upper circle): א, with the word מעלה ("above / upward") written to its right on the same level.
- ד (right-hand end of the short horizontal chord of the small upper circle): ד
- ב (left-hand end of the same short chord): ב
- ג (on the vertical diameter, at the lower pole of the small upper circle): ג
- Upper-left arc of the outer circle, written along the curve: קו השווה — the equinoctial line.
- Foot of the vertical diameter, below the outer circle: מטה ("below / downward").
- Left-hand end of the horizontal diameter, outside the outer circle, written vertically: מערב [?] — west (four sorts).
- Right-hand end of the horizontal diameter, outside the outer circle, written vertically: מזרח [?] — east (four sorts).

Labels not read, by position, with sort-counts:

- Centre, immediately right of the innermost small circle, on the horizontal diameter, black, horizontal: קו + א/ד/וּפֶן + [?] (three sorts). △ הארץ is WITHDRAWN to [?] on the sort count (adjudicated, Adjudication B, Locus 9); the middle word is recorded as א/ד/וּפֶן rather than left blank. The reading of the third word is UNRESOLVABLE and must not be

filled — see the QA note below for the three constraints any proposal must satisfy.

- Lower-left, written along the arc of the intermediate circle, black, rotated with the curve: עובי גלגל [recte: עובי גלגל] + a tail of two very small marks, NOT read. Δ Settled (Adjudication B, Locus II) — this is the label the census previously left unread; עובי is four sorts ending in a yod-scale floating mark, and גלגל is carried by TWO ceiling-breaking sorts at $\approx 1.8\text{--}2.0 \times x\text{-height}$, inside this codex's ל band. The tail is two marks far too small to be א or ב in this hand: [[אב/הב]] is REFUTED on size, and the tail is either gershayim or two yod-scale sorts — not adopted either way. See the QA note below.
- Lower centre, written vertically along the lower vertical radius, black: קו + one word of three sorts + היום. Read as קו ח?צי היום / קו ח?לק היום — the ל/צ discrimination is not settled on this leaf; I took neither.

f. 22v (source PDF p. 44)

Now a round hole [נקב עגול] is [?found] on all its sides, and the measure of its [?smallness] is as the thickness of the eccentric sphere. And in that small [?piercing] hole [בנקב המ?פלש הקטן] is set the globe of one small sphere, its measure being the measure of that hole — a very little less, so that it can revolve while it is there inside that hole. And all [?] the small spheres we have explained, and [?] that a sphere has [?] ... of the great spheres there is likewise one such small sphere, since the hole [?].

It has two poles, one in its north and one in its south, and they are fixed in the thickness of the eccentric sphere, [?in] position —. And [?] its sides, this [?] the small sphere; and upon the two poles and their [?] ends this sphere moves and revolves. The small [sphere] that is inside the hole revolves westward [?], or the reverse, as [?], as has been set out [?]. And the motion of the epicycle sphere of Levanah [the Moon] is like the rest of the epicycle spheres of the [?five] planets [ה' ככבים — ז/ה — ח/ד flagged] [?] —.

as stated. And know that the equinoctial line [הקו השווה] of this epicycle sphere is a line that revolves and rotates exactly opposite the equinoctial line of the eccentric sphere in [?alignment]; and there, likewise, the equinoctial line of the epicycle sphere is fixed together with [?]. The planet itself is as [?] a wall [כ?ד/ח?ופן] — the ח/ד discrimination not settled] that is made [?], since the body of the planet revolves exactly along the [equinoctial] line —. ... of the eccentric sphere, which in each and every planet [?], whether it moves with the motion of the eccentric sphere or the reverse, as noted. Therefore the planet continually revolves opposite the equinoctial line of the eccentric sphere. And just as we drew [?], we have drawn three lines on this epicycle sphere, aligned [מכוונים] — [?] to the measure of the three lines that are on the eccentric sphere; and they are the equinoctial line, the meridian line [קו חצי היום], and the horizon line [קו האופק].

Know also that, just as the eccentric sphere is divided into four quadrants [ד' רביעיים], into twelve parts [י"ב חלקים], and into 360 degrees [ש"ס מעלות], so is this epicycle sphere divided into all the parts already named, as [?] — as in chapter 9 [כפ"ט]. And now explain [?] the meaning of what we have [?]: the four letters ד א ב ג [ד' אותיות אבג"ד] [?] of the epicycle sphere [?]. Know that all the mean courses belong to it —

the [?] that all the great spheres have, those that have the earth at their centre. The beginning of their course starts [?] from the head of Aries [ראש טלה], which is [?] as the point of the half of the eastern horizon line, as above, as in chapter 9 [כנ"ל כפ"ט] —. [?] we divide, in each and every sphere of them, according to the direction [?] quadrants in this manner: for the first quadrant begins from the point at which the equinoctial line meets [?] the eastern horizon line, which is [?] the [breadth]; [?] and extends upward to the point at which the equinoctial line and the meridian line meet, opposite [?] the [abyss]. And from there the second direction [כיון הב'] begins, and extends to the point at which the equinoctial line meets the western horizon line, which is at the half of the [western] hemisphere. And from there the third quadrant [הרביעי הג'] begins and extends upward to the point where the meridian line meets the equinoctial line at [?] of the sphere, above our heads. And from there the [fourth] begins and extends to the point where the equinoctial line meets the eastern horizon line — [and these are] four quadrants [?]. Or, on this same order, they are divided into [twelve] parts corresponding to the twelve [signs / degrees — י"ב מנזע/לות], and every sign is divided ...

[Margin: a marginal note in the outer (right) margin, standing alongside the body lines that run from roughly the thirteenth to the seventeenth line of this side. Three lines, in a hand other than the scribe's — a paler grey-brown ink against his dense black, a finer nib, and a looser, more slanted cursive ductus, the lines sloping down to the left. Its wording is not given here.]

f. 23r (source PDF p. 45)

[Margin: foliation כג — two sorts, medial kaf + gimel, no geresh, in the outer (left) head margin, to the left of the running header.]

degrees, and so forth [מעלות וכי'] [?] ... the measure of the course of each one of those spheres [שיעור מהלך כל גלגל מהם], and they begin from [?] — [the middle of this line and most of the line that follows are not read] ... and also the epicycle sphere [גלגל ההקפה], which does not [?] encompass the world [שלהיו ומקיף העולם] — the five sorts before מקיף do not separate: שאינו and שלהיו both fit the ductus], and there is no —

the world [?] its measure, so that it does not revolve [שלא תסבב] [?] ... in its place [במקומו] [?] the piercing hole [הנקב המ/ת/פוי/פלש] [?] sphere. ... the bearing [sphere] [הנושא]; hence there is no capacity for motion [אין יכולת לתנועה] [?] alone [?], since its course —

changes [משתנה] [?] for [?] it was revolving [מתגלגל] [?] like the small epicycle sphere [כגלגל ההקפה הקטן] [?] do not separate in this hand; I took small, on the pairing with [גלגל ההקפה], like the upper half of the sphere [כח[צי] העליון של גלגל] —

That epicycle sphere recedes [ירחק] [?] from the east [מן המזרח] toward [?] ... [?] motion; and since the sphere [?] the lower half of [התחתון של] ... the said sphere [הגלגל הנז'] recedes [?] ... [?] in perpetual motion [?]; and like the rest of the five planets [וכשאר ה' ככבים] we have named —

— so that the epicycle sphere's motion is like the motion of the bearing eccentric sphere [שגלגל ההקפה תנועתו כתנועת גלגל היוצא הנושא], the case will be reversed [יהיה להפך]: for in the upper half it recedes [כח[צי] העליון ירחק] like planets moving of themselves [כמו ככבים מתנועע לעצמו], and in the lower half it recedes like planets moving of themselves [וכחצי התחתון ירחק כמו ככבים מתנועע לעצמו] — and therefore we have no [ולכן אין לנו] ...

They begin the count of the course of any epicycle sphere [מתחילין מספר מהלך] [?] ... only [?] the place where the fourth [?] begins [רק מקום] [?] ... [שום גלגל ההקפה] — the four sorts between [התחלת] and [הד'] are not settled], like the rest of the spheres [כשאר הגלגלים] [?] ... [?] all its motions [?] against [?] all [?], and like the place [?] ...

the south point [נק' הדרום], and we have [?] in it the letter א [ונשמענו בו אות א'], for there is the beginning of the first quadrant, as above, and opposite it another point [כשפל] [כי שם התחלת הרביעית הא' כנ"ל וכנגדו נק' אחרת], like the nadir [הגלגל כנגד התהום] [the same phrase stood on f. 22v], and there too [?] [וגם שם] the equinoctial line [קו השווה] ... with it the letter ג, for there is the beginning of the [?] quadrant [כי שם התחלת הרביעית] [ה?], and like the place ...

there another point, and we have [?]; and likewise the letter ב, for there [?] ... where the equinoctial line meets the eastern horizon line [קו השווה עם קו] [הרביעית הד'] there is a point [?] ... the fourth quadrant [האופק המזרחי]. And in this way [?] we [?] the revolution [?] of [?], and so [?] ...

of the five planets we have named [ה' ככבים שאמרנו]; for since the eccentric sphere [כי כהיות גלגל היוצא] ... [?] the south point in which [?] there [?] motion for the rest of the great spheres [הגלגלים הגדולים]; and here [?] the said planet [וכאן נק' הכוכב הנ"ל], and therefore we have [?] ...

where the equinoctial line meets the meridian line [פגישת קו השווה עם קו] [כדרום גלגל ההקפה] ... [חצי היום] toward the south of the epicycle sphere [התחלת הרביעית הנ"ל כנ"ל וכנגדו נק' אחרת], like the nadir [כשפל] ... the equinoctial line with the meridian line, and there is the point of the southern nadir [שם נק' שפל הדרום], and we have [?].

And at the place where the equinoctial line meets the eastern horizon line [וכמקום פגישת קו השווה עם קו האופק המזרחי] there is [?] the beginning of the second quadrant [התחלת הרביעית הב']; and opposite it [?] the meeting [?] ... another

point, and we have [?] with it the letter ד, for there is the beginning of [נק'] ... [אחרת ונשמענו בה אות ד' כי שם התחלת

between the epicycle sphere of [?] and the rest of the epicycle sphere [בין] גלגל ההקפה של [?] לשאר גלגל ההקפה — the two or three sorts naming the body are not read; ירח cannot be excluded] ... [?] the zenith point of the epicycle sphere [נק' רום הגלגל של ההקפה] ... this course of the epicycle sphere, and the course of the sphere [מהלכה הזה של גלגל ההקפה ומהלך גלגל] ...

begins [?] backward [מתחיל [?] לאחור] and goes [?] from the south point, which is called [מנק' הדרום שקורא] ... [?] against the motion, backward, for such is the order of [?] [נגד התנועה לאחור כי כן סדר ה]; its motion moves perpetually [תנועתה מתנועע לעולם הפך תנועת גלגלה] the reverse of the motion of its own sphere

the eccentric [sphere], which is turned [היוצא שתוסבב] [?] moving backward, as above [מתנועע לאחור כנ"ל] [?] ... as in chapter 3 [כפ"ג] — could equally be [כפ"ב], it was not pushed back further [לא נדחתה יותר] [?] as it goes backward [לאחורנית], because ...

which goes the reverse of the course of its own eccentric sphere [שהולכת הפך] [מהלך גלגלה היוצא], and also [?] ... [?] it was pushed back [?] here [?] from the beginning [?] in its motion, since [כתנועתה כיון] — [line-filler dash]

that its motion is backward [שתנועתה לאחור]; and when it reaches the point ד [וכשתגיע מנק' ד'] [?] motion [?] ... it does not begin to become direct [כי הולכת לצד התנועה] [לא מתחלת להתישר] since it goes toward the motion [התנועה]

like the course of its own eccentric sphere [כמהלך גלגלה היוצא] [?] ... its swiftness [מהירותה]; and when it reaches the letter ג, which is the southern nadir [וכשתגיע כאות ג' שהיא שפל דרום] ...

not [?] the utmost of its swiftness [ולא תכלית מהירותה] [?], because it goes against the motion of [כי הולכת נגד תנועת] ... and when it begins to revolve from there and to rise toward the point ב [נק' ב'] [וכשתחיל לסבב משם ולעלות אל נק' ב']

... [?] it returns [?], because it goes against the motion; and also it [?] ... it is at the utmost of its swiftness [היא בתכלית מהירותה]; and when it rises further [וכשתעלה עוד] [?] moving [?]

f. 23v (source PDF p. 46)

To the letter א [לאות א'] it begins to turn back backward [תתחיל לחזור לאחורנית], and it too does not move [?] [וגם היא לא מתנוע] ... [?] to the point א [נק' א'] [?] from א [?] of ד [?] its course backward [מהלכה לאחורנית] ...

it returns [ישוב] [?]; there remain the five planets [ככבי לכת] [ישאר ה' ככבי לכת], so as to be [להיות] [?] ... like the motion of its bearing eccentric sphere [תנועת גלגלה] [היוצא הנושא], the matter will be the reverse [יהיה הדבר להפך] [?] ... the south, which is the point א, or at the point of the southern nadir [נק' א' או] [כנק' שפל דרום] ...

again, as above [?], the course of their epicycle sphere and the course of their [own] sphere [מהלך גלגל הקפתם ומהלך גלגלם] ... and at the point ג, at the utmost depression of the epicycle sphere [הקפה] ... from the point ד to the zenith point [מנק' ד' לנק' רום] its course returns [מהלכה ישוב] ... its course returns the reverse [?] a little [?] as we have said [מהלכה ישוב הפך מעט שאמרנו]

the beginning of the motion [מתחלת התנועה] [?], for as it moves from the point [כי כתנועתה מן נק'] backward; and as it moves from ד to ג, and from ג to ב, its course [וכתנועתה מן ד' אל ג' ומן ג' לב' מהלכה] ...

for the motion of their epicycle sphere moves toward the depth [כי תנועת] ... the reverse; for [לעולם/לעומק] — [?] גלגל הקפתם היא מתנועע לעומק [להפך כי בהיות [?] ככב מקום כנקודת] ... when the planet's [?] is at a place, as the point [הנה לא מהלכם] ... [?] as [?] their epicycle sphere — here their course is not its bearing sphere; and as it is in their motion, it is toward the south [גלגלה] — [הנושא וכהיותו כתנועתם הוא כדרום]

its revolution [הקפתו], and its going [?] from the zenith point to the point ב, or as it rises [וכלכ] [תו מנק' רום לנק' ב' או כעלותו] ... [and its going] from the point מנק' ב' לנק' ג' ומנק' ג' אל ד' לא [?] [?] to the point ג, and from the point ג to ד, not [?] ...

for its revolution [?] like the upper [?] of the epicycle sphere [כי] ... for all five planets it is the reverse [סיבוב/כ]ה כאחד העליון של[ה] גלגל ההקפה [ודע כי כהיות הככב] ... [כל ה' ככבים הוא להפך]

backward, and at the point ב it is called the first station [וכנק' ב' נק' מעמד א'] ... backward; and since they are [?] ... [ובהיותם כנק' ד' נק'] ...

point ד, or at [?] point, [?] their [?] [נק' ד' או ב' נק'] [?] since they are [?] ... that they do not begin to become direct [שלא מתחילים להתישר]; and when it is at the zenith point [ובהיותו כנק' הרום] ...

their directness, and it is found [?] going [?], it begins to return backward [וישירותם ונמצא [?] מתחיל לשוב לאחורנית] ... what was pushed back at times [מה שנדחת לפעמים] the [?] —

the second station, for their [?] was not completed [השני כי לא נשלמה] ... [?] great [?] in their motion [גדולים כתנועתם] —

the point of swiftness; and the point of depression is called the resting point [נק' מהיר וכנק' השפל נק' שוכב וככה יגדל] ... [?] day [?] its course [?] to five [?] [מהלכו לחמש] [?] as in the matter of the course of [כענין מהלך] ...

for the rest of the planets have it, apart from Shemesh [the Sun] [חוץ מן השמש] — the four sorts read ש מ ש ה; this is not the חמה of the glossary, and I have not conflated them], which has no epicycle sphere [שאיין לו גלגל הקפה] ... the five planets we have named [ה' ככבים שאמרנו] ... their revolution [הקפתם] ...

backward [?], and therefore [?] it moves the measure of its course [וע"כ] [מתתנועע שיעור מהלכו] ... there is also [?] the course of their eccentric and bearing sphere [עוד מהלך גלגלם היוצא והנושא], therefore — [line-filler dash]

the fifth [?] and the fifth [?] to the point [?] doubled [?] [החמישי ונחמישית] ... [?] to be gathered [?], because [?] toward the matter of their revolution [לענין הקפתם] ... great, in the measure of the course of the epicycle sphere [גדול כשיעור מהלך] [גלגל ההקפתם], to the measure [לשיעור] ... backward, and it is found [?] entire [?] —

the revolution [?] strong [?] small [?] point [?] direct [?] [ההקפה חזק קטן נק'] [?] not separated here; four further sorts unread] ... the course of the bearing sphere, as above, as in chapter 3 [מהלך גלגל הנושא כנ"ל כפ"ג] ... for the point [?] the measure [כי נק' שיעור] ...

for, just as [?] in them, and they are found [?] going, it returns [?] ... reversed [?] moves [?] between [?] the course of the epicycle sphere [מהלך גלגל ההקפה]

... its course is 12 [?]13] degrees and 30 minutes each day [י"ב/ג מעלות ול'] — the sort after the gershayim does not separate ב from ג], and only [?] its course is 13 degrees and 30 minutes [דקים ול"א] — a ל"א = 31 reading of the second figure cannot be excluded], and the measure is close [והשיעור קרוב] ...

very greatly, and therefore they have no [?] [אין להם], and they are found [?] pressed [?] ... but rather [?] singly [?] and swiftly [ליחוד ומהירות] [?], and almost [?] ...

in swiftness [במהירות] · [a clear word-space here: the scribe leaves a gap of about three letter-widths, then the line runs on] and [?] [?] the planets [הכוכבים] ... it is that [?] their [?] are not [?] [?] ... and when they are [?] their [?] [?] deeds [?] and [?]

and [?] concerning the matter, and therefore [?] does not [?] them [?] ... [?] for it happens at times [?] without [?] and its motion [ותנועתו] ... [?] it happens [?] it delays backward and becomes direct [מתאחר לאחורנית ומת[?]ישר] ... [these last four lines are largely unread] ... · And know that [יודע כני] [?] when [?] it is [?] the rest [שאר]

f. 24r (source PDF p. 47)

[Margin: foliation כד — two sorts, medial kaf + dalet, no geresh, in the outer (left) head margin, well clear of the running header.]

The stars at the south point [הדרום בנק' הדרום], when they are in their epicycle spheres [כאשר בגלגלי הקפתם] [?] — they are the ones farthest from the center [הם הרחוקים מאד מן התוך], since [?].

For the globe of the epicycle sphere [שכדור גלגל ההקפה], through the whole measure of its revolution [כל שיעור סיבובו], is distant [?] by the measure of the

thickness of the bearing eccentric sphere [רי'חוק עובי גלגל היוצא הנושא] [?] in the sphere —

It follows, then, that the south point, when it is in the epicycle sphere [נמצא כי] was [?] ... upon the thickness of the eccentric sphere [על עובי גלגל היוצא] — [the four or five sorts between היה and על are not read] ...

for there it adheres to the other great sphere [כאשר שם נדבק עם הגלגל הגדול] [?] which is above it [אשר עליו]; and its point of depression [ונק' שפלותו] [?] the inner [הפנימי] ...

of the thickness of the sphere, when it is nearer to the center [של עובי הגלגל] [?] [כאשר הוא יותר קרוב אל התוך] the sort after ה אל is taken as tav on the pairing with וך, giving התוך, the term standing twice more on this side]; and a star [וככב] [?] for the motion, the measure of the thickness of the sphere [לתנועה שיעור עובי גלגל] ...

the eccentric sphere of each and every star [היוצא של כל כוכב וכוכב]; therefore, when the star is [ולכן בהיות הככב] far [?] at the point of depression of their epicycle sphere [הרחוק] — [line-filler dash]

it is very near the center [הוא קרוב מאד אל התוך], and this [?] ... and when they are at the [zenith] point they are the ones distant from the center [ובהיותם] [line-filler dash]

(interlinear: רום — a single word written small above the line, standing over the gap between בנק' and הם. Read as the scribe supplying the qualifier rom (zenith) to נק')

at the utmost of the distance [בתכלית הריחוק], and [?] they [?] ... 30 [?] and 50 [?] seconds in this minute mentioned above [ל' ונ' שניות בדקה זו הנ"ל], and when they are [?] ...

the places of their epicycle sphere [מקומות גלגל הקפתם] are for them in the upper half [להם הוא בחצי העליון], which goes to [?] [הולכת להת], and for them in the lower half [ולהם בחצי התחתון].

they go toward drawing near [הולכים להתקרב]. And know that all that is in the epicycle sphere [ודע כי כל מה הוא בגלגל ההקפה] ... however, there is a further zenith [רום ושפל] — [?] zenith and nadir [רום ושפל] —

zenith in their eccentric spheres [רום בגלגליהם היוצאים] [?], for also [?] ... from within [?] the globe of the earth [נשל כדור ה[ארץ/תוך] [?] and their motion for them [ותנועתם להם] ...

zenith and nadir; the zenith [?] degrees [כמעלות] [?] as in chapter [?] [כפ"ב/ג/י"ב] [?] except that they are [?] [אלא שהן ב] ... stars, the point [?] [נבדל] [?] ... like [?] [כמ'] ...

they have a star at a point of zenith and nadir — the zenith which is in their epicycle sphere [להם ככב בנק' רום ושפל רום שבגלגל הקפתם]; and they have a star at a point of zenith and nadir — the zenith which is in its own [רום] [ולהם ככב בנק' רום] — [ושפל רום שבגלגלו] —

eccentric sphere [היוצא]. And sometimes it happens that the star [ביתר/ב/יח/ד — together?] [ב' הבחינות] [?] the two respects [ולפעמים יקרה שהככב]

not settled] ... and it happens [ויקרה] [?] the zeniths, or [?] the nadirs [הרומים או [?] השפלים] ...

and sometimes [ולפעמי] [?] of the two of them [משניהם] [?] ... by the measure of [?] their course [כשיעור מ[?] מהלכם]; but Shemesh [the Sun] [השמש] has only the first respect [אין לו רק הבח' הא'] — [line-filler dash]

that they are two points, zenith and nadir — the zenith in its eccentric sphere [שהם ב' נק' רום ושפל רום בגלגל היוצא] [?]; but the [?] respect it does not have, or it has [אין לשמן[ש] [?] not to Shemesh [אבל הבח' ה[?] אין לו או יש לו] —

the epicycle sphere, as above [גלגל ההקפה כנ"ל] [?], as in chapter [?] [כפ"ד] [?]. And know that the scholars [ידע כי החכמים] altered [?] the motion of the point of [?] or thus [או כה] — [line-filler dash]

that they should not [?] be interchanged [שלא יתע[כר]בו להתחלף], as their words make plain [כביאור דבריהם], in the strengthening of the sphere [בחיווק גלגל] [?] their [?]; and therefore toward the two points, the [?] [ה' הנק' ה'] [?]

...

toward [?] the eccentric sphere [ל[צ/ש]ד בגלגל היוצא] [?] and thus zenith and nadir [שפל רום] [and] zenith [ובכך רום ושפל] [?]; but toward the two points, the [?] [כאשר בגלגל ההקפה] [?], when in the epicycle sphere [אבל אל ב' הנק' ה'] [?]

they call them by the name "the far distance" toward the point of the [?] [יקראום בשם מרחק הרחוק אל נק' ה[ד]רום], and "the near distance" toward the point of the nadir of the zenith [ומרחק הקרוב אל נק' שפל רום], and [?] a general rule [כלל] ...

only to reckon places [רק לחשוב מקומות] [?] to them [אליהם], like the stars [כמו הכוכבים]. And know that, when they are [ידע כי בהיותם] [?] at the zenith point, the point [בנק' הרום הנק'] ...

the far distance mentioned above [מרחק הריחוק כנז'] [?]; if it happens [אם יקרה] [?] great [גדולה] [?] ... expression [לשון] [?] it is very small [הוא קטן מאד] and more correct [ונכוחה יותר] ...

[Margin: a pale grey hooked stroke stands in the lower left margin, clear of the text block's left edge. Grey, unmodulated, no ink body — the paper's watermark, not an annotation.]

And sometimes [?] [ולפעמים ל] [?] the measure of [?] degrees and three [שהוא שיעור] [?] ... as above, as in chapter [?] [כפ"ד] [?]

and when it is at the near distance [ובהיותה במרחק הקרוב] [?] [the ואז ולא] [?] ... far greater, since it is nearer [יותר גדולה מאד לפי שהיא יותר קרובה] ...

and now we shall explain [ונבאר עתה] [?] ... there are found the [five?] planets [הם כי בהיות] [?] — they are, when [?] is [נמצא [ה'] ככבים שאמרנו] [?] in the thickness of [ב[עוב]ה[י]] the zenith of [?] [?] ...

[?] degrees [מ[עלות] [?]] and [?] [ות[?]ד] to the [?] [לקום], it begins to be [גמור] [?] wholly [מתחיל להיות] [?] [עומד] [?] stationary [ר"ל], and when it is [מעלות] [?] degrees [וכשתהיה] [?]

three degrees and [?] [ג' מעלות ו[?]"] to the [?] [לקום], it begins [?] to become direct [להתישר]; and when it is at the nadir of the zenith [וכשהוא בשפל רום] [?] degrees, and [?] degrees [מעלות ו[?] מעלות [?] ...

and thirty minutes [ול' דקים] it is [?], and in [?] ... [?] degrees and thirty minutes, as above [נ"ד?] מעלות ול' דקים הנ"ל], and [?]. Tzedek [Jupiter] [צדק], when it is [בהיותו] —

f. 24v (source PDF p. 48)

[A pale brown rounded mark stands in the right head margin, well clear of the text block. Diffuse, edgeless, no ink body — show-through from the other side of the leaf, not an annotation.]

In the thickness of its apogee [בעובה רומו] — [?] degrees and [?] degrees and [?] minutes, it is [?] [חזור/גמור]; and when it is at [?] degrees, and twelve [וי"ב] —

degrees and forty-three minutes [מעלות ומ"ג דקים] it is direct [הוא ישר]; and when it is at the perigee of its zenith [וכשהוא בשפל רומו], thirty degrees [ל' מעלות] and [?] degrees and eleven minutes [וי"א דקים], it is [?] [חזור/גמור] —

and when it is at [?] degrees — twelve degrees [י"ב מעלות] and [?] minutes — it is direct [ישר]. Ma'adim [Mars] [מאדים], in the thickness of its apogee: five degrees [ה' מעלות] [?] ...

[?] degrees, twenty-five minutes [כ"ה דקים] exactly [גמור]; and when it is at [?] degrees — twenty-two degrees [וכ"ב מעלות] and thirty-three minutes [ול"ג דקים] — it is direct [הוא ישר] —

and at the perigee of its zenith [ובשפל רומו], [?] degrees and [?] degrees and [?] minutes, it is [?] [חזור/גמור]; and when it is at [?] degrees and ten [ועשר]

... degrees and [?] minutes, direct [ישר]. Nogah [Venus] [נוגה], in the thickness of its apogee: five degrees [ה' מעלות], [?] degrees and fifty-eight minutes [ונ"ח דקים], it is [?] [חזור/גמור] —

and when it is at [?] degrees — fourteen degrees [י"ד מעלות] and [?] minutes — direct [ישר]; and at the perigee of its zenith, five degrees [ה' מעלות], [?] degrees

... twenty-seven minutes [כ"ז דקים] exactly [גמור]; and when it is at [?] degrees and [?] degrees and [?] minutes, direct [ישר]. Kochav [Mercury] [כוכב], in the thickness of its apogee [בעובה] ...

[its apogee?], thirty degrees and twenty-two degrees and fourteen minutes [רומו ל' מעלות וכ"ב מעלות וי"ד דקים], retrograde [?]; and [at] [?] degrees and thirty degrees and [?] minutes, direct [ישר] [מעלות ומ?] דקים ישר] —

and at the perigee of its zenith [ובשפל רומו], [?] degrees and [?] degrees [?], and forty-two [?] minutes [ומ"ב דקים], retrograde [?]; and when it is at [?] degrees and [?] degrees ...

and eleven minutes [וי"א דקים], direct. And know that [ידע] [?] it shifts a little [נעתק מעט] toward [?] its epicycle [הקפתו] [?]. And now we shall set out

the measure of the distance of each one of the stars [ונבאר עתה שיעור הרחק כל א' [הככבים] ...

the epicycle sphere, which hold [ההקפה המחזיקים] [?] at the time of their being a point, as above [בעת היותם נקודה כנ"ל] ...

[?] — ...

Shemesh [the Sun] is aligned opposite the center of the epicycle sphere of the star [השמש מכיון כנגד מרכז גלגל הקפת הככב] [?] ... as above [לעיל], for the sphere [כי גלגל] ...

above [לעיל] [?] ... small [?] [וקטן/צפון] [?] ...

as above. And know that when the star is at the point of the perigee of its epicycle sphere [שפל גלגל הקפתו] [?] which is [?] the near distance [המרחק הקרוב] ...

as above — that is to say [ר"ל], when it is aligned to the sphere of the [degrees / signs] [לגלגל המ[עז/ז]לות] — it is not retrograde [לא נחזור]. And the measure of the reckoning of the distance of their parts [ושיעור חשבון הרחק חלקיהם] ...

the epicycle itself [ההקפה עצמו], and what it is on every side, above its sides [ומה הוא מכל צד מעל צדדו] [?] ...

there the star comes to be retrograde, backward [שם הככב להיות נחזור לאחורנית], and it is found [ונמצא] [?] ... and above, on every side, it is called direct [ונעשה רוב] ...

the motion of the center of its epicycle sphere [תנועת מרכז גלגל הקפתו] [?] all that [?] ...

[?] and Tzedek [Jupiter] 25, and Ma'adim [Mars] 18, and Nogah [Venus] 13, and Kochav [Mercury] [?] — [?] [וצדק כ"ה ומאדים י"ח ונוגה י"ג וככב ל] [?] ...

and further, when the star shifts away from Shemesh [כאשר יעתק] [?] in its epicycle sphere [בגלגל הקפתו], while Shemesh is aligned [בהיותו והשמש מכיון] [?] ...

at a point above its side, or toward the [?], or toward the [?] [בנק' מעל צדדו] [?] — they are twenty-five parts only [הם כ"ה חלקים בלבד] [?] and Nogah [Venus] [?] parts [ונוגה מ[?] חלקים] ...

and it is found, according to what [ונמצא כפי מה] [?], that in the doubling, at the point [כי בכפל בנק'] [?], it is [?] ... the measure of its smallness [שיעור קטנה] [?] ... for the word [מלת] [?] — that is to say [ר"ל] ...

the thickness of the whole sphere, from its beginning to its top [עובי כל הגלגל] [?] parts from the star to the distance of the sphere [למרחק גלגל] [?] ...

its epicycle sphere, and likewise to its top [הקפתו וכ[?] למעלתו] [?], they are three parts [הם ג' חלקים] [?] ... the measure of the diameter of the epicycle sphere of Kochav [Mercury], and the diameter of the sphere [קוטר גלגל הקפת כוכב] [?] ...

the epicycle of Nogah, at the point — here, at the point, [?] parts [הקפת] [?] [נוגה בנק' הנה בנק'] [?] [חלקים] [?] yields [יתן] [?] ...

the thickness of the wall of its eccentric sphere [עובי הדופן של גלגל היוצא שלו], thirty-two [ל"ב] [?], at the point [בנק']. That is what we said: the measure of the thickness of their [?] spheres [שלהם] [?] הגלגלים ה[?] ...

f. 25r (source PDF p. 49)

[Margin: foliation כה — two sorts, medial kaf + he, no geresh, in the outer (left) head margin.]

For the thickness of the wall of the eccentric sphere that bears Nogah [Venus] [כי עובי דופן גלגל היוצא הנושא של נוגה] is thirty parts [ל' חלקים] [?], the measure of its epicycle sphere [כשיעור גלגל הקפתו] — [line-filler dash]

And the thickness of the wall of the eccentric sphere that bears Kochav [Mercury] [ועובי דופן גלגל היוצא הנושא של ככב] is [?] parts [ט/נ' חלקים] [?], the measure of the diameter of its epicycle sphere [קוטר גלגל הקפתו].

And [?] it does not recede from Shemesh [the Sun] [לא תתרחק מן השמש] by more than [?] ... [?] minutes [דקים]; and this is the [?] between [?] [וזהו] — [line-filler dash]

[?] to [?] ... moreover [עוד] ...

the diameter of every eccentric sphere of every star, which is what we said [קוטר כל גלגל היוצא של כל ככב מהו שאמרנו] ... and we draw a straight line through [?] its centre [ונמשיך קו ישר דרך [?] מרכזו] — [line-filler dash]

its circle, its distance to the point of its seat; and we take half the measure of the diameter [מעגלו מרחקו אל נק' מושבו ונקח חצי שיעור קוטר] — divide [?] this line [חצי קטרו וכשנחלק] [?] half its diameter, and when we divide [חלוק הקו הזה] [?]

... this half into [?] parts [זה החצי אל ו/ג' חלקים], when [?] ... the diameter of the bearing eccentric sphere, as mentioned [קוטר גלגל היוצא הנושא כנו'], we find that [נמצא כי] —

half the diameter of the epicycle sphere of Shabtai [Saturn] is six parts and a half [חצי קוטר גלגל הקפת שבתי הוא ו' חלקים וחצי]; Tzedek [Jupiter], eleven and a half [וצדק י"א וחצי]; Ma'adim [Mars], thirty-[?] and a half [ומאדים ל"ז וחצי]; and Nogah [Venus] ...

forty-three and a third of a part [מ"ג ושלישית חלק]; Kochav [Mercury], twenty-two and a half [וככב כ"ב וחצי]; and [?] [זו/נ' חלקים] seven parts and a third [ז' חלקים ושליש] — and all this reckoning [?] is taken approximately [וכל ה[חשבון]] בקירוב [הזה נק'וט].

[?] and not in alignment [ולא בכיוון] [?] —

[BODY HEADING, GOLD DISPLAY] פרק נ"א — ON THE EXPOSITION OF THE GREAT SPHERES

Chapter [51 — see the note: the value is what the leaf writes and the chapter series cannot accommodate it] [פרק נ"א]. On the exposition of the great spheres [בביאור הגלגלים הגדולים] [?] — that is, the resembling, the [?], and the eccentric [והם הדומים והנועים והיוצאים] [?]; and already [וכבר] — [line-filler dash]

[?] wrote that [כתב' כי] [?] the planets [לכנת] [?] ... [?] alone there are three kinds of great spheres, the resembling [מיני גלגלים גדולים] [הדומים] ...

the motion and the eccentric; and the sense of [?] — that is to say [ר"ל], that [?] toward the sphere of [?] [אל גלגל המעלות] [?] ... and there are in it kinds differing one from another [ויש בו מינים שונים זה מזה] ...

[?] ... for they are [?] that it should be touching and also eccentric [שיהיה נוגע וגם יוצא] [?] ...

And so the resembling sphere, in all its aspects [?], is like the sphere of degrees [והנה הדומה בכל פאתיו לגלגל המעלות] [?] — it is the resembling sphere of Chamah [the Sun] and of Levanah [the Moon] [הוא הגלגל הדומה של החמה ושל לבנה].

[?] small [קטן] [?] ... and the resembling one, like [?] the cord of the sphere [אינו יוצא וגם נוגע] [?], is not eccentric but is touching [והדומה כמעקלת חבל הגלגל] — these are the first spheres [הם הגלגלים הראשונים] [line-filler dash]

the resembling spheres of the five [?] stars we named [הדומים של ה' ככבים שאמרנו]; however, the sphere [ואמנם הגלגל] [?] — the one called [?] is thinner than they [הנק' דק מהם], and the touching sphere is touching [וגלגל הנוגע הוא נוגע] ...

but for Chamah it is not eccentric, and [?] they are the second sphere of Kochav and Levanah [הם הגלגל הב' של ככב ולבנה], since these are touching and not eccentric [כי הם נוגעים ולא יוצאים] but [אבל] —

the eccentric sphere is thinner [?] than they [הגלגל היוצא דק מהם]; there are in it two kinds [יש בו ב' מינים] — either it is eccentric and not touching [או שיהיה יוצא לא נוגע], and this is the sphere [והנה הוא הגלגל] ...

the second of Chamah; or it is eccentric and touching [או שיהיה יוצא ונוגע] — and this is the second sphere of Shemesh [the Sun] [?] [והנה הוא הגלגל הב' של] ... and the third sphere of [של] [שמן] ...

Kochav and Levanah [ככב ולבנה]; however, in this [ואמנם בזה] [?] the two of them [שניהם], for so [?] — thus the touching one is [?] eccentric and not touching [כן הנוגע ל[א/ו] יוצא ולא נוגע] ...

all of them share in being called by one name [כלם משתתפים במה שנק' בשם] [אחד], and it is the bearing sphere [והוא הגלגל הנושא]; and the reason for this is that the eccentric [וטעם הדבר כי היוצא] ...

of Chamah never has a small sphere of epicycle [של חמה לעולם שאין לו גלגל] [קטן של הקפה]; even so it is called "bearing" [עכ"ז נק' נושא], since the star Chamah [יען כי ככב חמה] — [line-filler dash]

itself is fixed in it [עצמו קבוע בו]; and so it bears it [והנה הוא נושא אותו]. And the eccentric and the touching of [?] [והיוצא והנוגע של שמ] is called the bearing sphere [נק' הגלגל נושא] ...

since it bears the epicycle sphere set within it [יען נושא את גלגל ההקפה המונח] [בו]; but the resembling one, which is [?] touching, is not called by the name "bearing" [אבל הדומה ל[א/ו] נוגע אינו נק' בשם נושא] ...

since neither the star nor its epicycle sphere is set within it [יען אין הככב] [?] ... itself, to the eccentric sphere, as mentioned [עצמו אל הגלגל היוצא כנו'] — [ונבאר עתה]

the matter of the touching spheres. We have already explained, as in chapter [?] [ענין הגלגלים הנוגעים כבר ביארנו כפ'] [?], what is the reason for the giving of this [?] [מה היא טעם נתינת ה[?] הזאת]; for indeed, just as [כי הנה כמו] ...

that the resembling sphere is called by the name [?] of the sphere of degrees [גלגל המעלות], so the touching sphere is called by the name [?] of the sphere [גלגל] —

[Margin — the gloss band, f. 25r outer (left) margin. Recorded, not read. It runs down the outer margin, beginning level with the fourth written line and stopping about six lines above the last. Line count ≈ 14 , measured rather than counted whole. Ink: a grey-olive, markedly paler and browner than the scribe's dense carbon black on the same opening — the difference is plain where gloss and body stand side by side. Ductus and size: looser and more irregular than the body hand, with blunt blobbed stroke-ends and wider letter spacing; the gloss's line pitch is about 45% greater than the body's, so the annotator writes distinctly larger. No ink runs off a panel edge: blank paper stands between the gloss and the leaf's outer edge on one side, and the body text block begins just beyond its ink on the other. No words are committed and no specimen is offered: nothing in the band was unmistakable to me at this magnification. Whether this hand is the same as f. 25v's is answered below, after that band was looked at.]

f. 25v (source PDF p. 50)

the degrees, and [?] ... the matter of the touching [?] of the sphere of degrees [ענין נגיעת גלגל המעלות] [?] ... it too [?] is called "touching" [נק' נוגע], as mentioned [?] there [כנז' שם] [?] — [line-filler dash]

for [?] the measure [?] [כי ה[ש]יעור] ... it is [?] the second diurnal sphere [הגלגל היומי הב'], from above downward [מלמעלה למטה] [?], as in chapter [?] [ככפ"ב/ג] [?] —

for it surrounds [?] [כי הו[א] מקיף] ... spheres one within the other [והנה כל בחינותיו הם]; and indeed all its aspects are in alignment [מכוונים] —

like the aspects of the terrestrial globe [כבחינות כדור הארץ], as mentioned [?] there [כנז' שם] ... [?] its centre [?], and its two poles and its two lines are in alignment [וב' קטביו וב' קוים שלו הם מכוונים] — [line-filler dash]

over against the [?] and the poles and the lines of the globe of the earth [כנגד גלגל המעלות] [?], and [?] ... the sphere of degrees [גלגל המעלות] ... within it [בתוכו] [?] —

equal to it [?] [שוה לו] [?] ... as with the poles and the lines [כענין הקטבים והקוים] [?] — [line-filler dash]

poles and lines of the diurnal sphere [קטבים וקוים של גלגל היומי]; and it has already been [?] [וכבר נת'] ... its diameter [?] [קוטרו] ... [?] its lesser [?] [הקטן שלו] —

and the small division of it [?] [והחלוק הקטן שלו] above the pole [מעל הקטב] [?] — and the small division of the diurnal sphere [והחלוק הקטן של גלגל היומי] is twenty-[-?] degrees [כ"ב/ג מעלות], and [?] ...

minutes, according to most of the sages [דקים לפ' רוב החכמים]; and over against this [?] [וכנגד זה] ... the pole and the [?] southern [הקטב והדרומי], above [?] a pole and [?] ...

the southern one of the diurnal sphere [הדרומי של גלגל היומי]; and you already know that the equinoctial line cuts the sphere [והשוה חותך הגלגל] [?], and it leaves [?] its part [?] ...

[?] toward the south [לדרום], and it is [?] ... the two poles of the equinoctial sphere [?] [ב' קטבי הגלגל השוה]; and it has been explained that, since [?] a pole [ונתבאר כי כיון ש?] קטב] — [line-filler dash]

its lesser [?], upon that of the diurnal sphere [הקטן שלו על של גלגל היומי]; so too [?] [כמו כן] ... its equinoctial line toward the south side [?] [קו השוה של גלגל] ... the equinoctial line of the sphere [קו השוה שלו לצד דרום]

the diurnal [?], its lesser part [?], the measure mentioned [השיעור הנז'] which are [?] ... twenty-[-?] degrees and [?] minutes [דקים] [כ"ב/ג מעלות ול?] דקים]; and over against this [?] [וכנגד זה] [?] — [line-filler dash]

the lower one of its equinoctial line, toward the south [?] [התחתון של קו השוה] [?] [שלו ל]צד] דרום] from the [?] ... the equinoctial line of the diurnal sphere, by this same measure [הקו השוה של גלגל היומי כשיעור הזה עצמו].

And indeed the equinoctial line of the degrees is always fixed [והנה לעולם] [?] the motion of their degrees [?] is twelve [?] degrees [תנועת המעלות שלהם י"ב מעלות] ...

parts toward the south [?] [חלקים לדרום]; the line is divided [הקו נחלקים] [?] [שיעור התנועה הנז'] [ועכ"ז] ... and even so [?] [כפי נטיית התנועה] [?] ...

according to the inclination of the equinoctial line, which divides [?] [הקטב והקו הקטן] is [?] ... [כפי נטיית קו השוה החולק] [?] ...

twenty-[-?] degrees and [?] minutes [?] [דקים] [כ"ב/ג מעלות ול?] דקים] ... and so [?] [ולכל רוחב ה?] [?] ... to the whole breadth of the [?] [וכן] toward the south [?] ... [שתתפשט יותר] —

toward the south and to the lesser [?] [לדרום ולקטן], and the joining of this [?] [וכבור זה] [?] ... as with the touching spheres [כי כל התנועות] [הם] — [line-filler dash]

as with the equinoctial line, in it specifically, not [?] [כענין קו השוה שבו דוקא] [?] [של גוף הככב קבוע בקו השוה] [?] [וכן] ... [?] [וכן] ... of the body [?] of the star, fixed on the equinoctial line [?] [וכן] ...

it is by reason of the poles and the divisions, as mentioned [הוא על שם הקטבים] [?] [והחלוקים כנו'] ... and it has been explained that the [?] of degrees incline [?] [גלגל] [?] [ונתבאר כי] [?] [המעלות נוטים] — [line-filler dash]

the diurnal [?] above [היומי למעלה]; all the motions mentioned [?] [כאשר ככב] ... [?] to know that [?] in [כל התנועות הנז']

their spheres they incline [?] and are not [?] eccentric [ול[א/ו] ו] ... [יוצאים]

Whether among their [?] spheres or the inclining ones [?], they are as with [?] [כענין] ... the sphere of degrees, and the joining [?] in this sphere [גלגל המעלות וחבור בגלגל זה] · and in another [ובאחר] — [line-filler dash]

The matter of their inclination [ענין נטייתם]: the measure of the inclination of the equinoctial line [הנה שיעור נטיית הקו השווה] of the second sphere of Shabtai [Saturn] [של גלגל ב' של שבתאי] — [line-filler dash]

the sphere of degrees; they are three parts [?] [גלגל המעלות הם ג' חלקים], and Tzedek [Jupiter], twenty- [?] [ו]צדק כ"ח], and it is found [?] [ונמצא] ... [?] thirty [?] parts and a third [ל' חלקים ושליש], and [?] seven parts [ז' חלקים] ...

and Nogah [Venus], fif[?] [ונוגה ט"ו/ז], and [?] ... in their spheres they are three parts [ג' חלקים] ... [?] and Kochav [Mercury], [?] [וככב] [ח"ח], and Levanah [the Moon] — her touching sphere [ולבנה גלגל הנוגע שלה], which is called [?] [שהנה] ...

the second sphere [גלגל הב'] [?] from the equinoctial line of the degrees [מקו השווה של המעלות] ... [?] northward [?], and it is divided southward [ל]צפון], after the manner of the inclination of the equinoctial line [כדמיון נטיית קו השווה] ...

of the degrees, from the equinoctial line of the diurnal sphere [של המעלות מקו] [השווה של גלגל היומי], and it is found [?] [ונמצא] ... [?] the limit of its inclination [הנה] ה' מעלות ומחצי[ת] [?] five [?] degrees and a half [?]

[Margin — the gloss, f. 25v outer (right) margin. Recorded, not read. It is a short note of two, possibly three, lines — not a long band. This is the first thing to say about it, because it is where it differs from f. 25r's. It begins level with the last written body line and runs a little below it, so it sits at the foot of the measure, in the blank paper the scribe left. The rest of the outer margin is empty. That is a census, not an impression: every other panel of the outer margin, in both the outer and the inner column, was examined and each carries no gloss ink at all. No ink runs off a panel edge: blank paper stands between the gloss's rightmost stroke and the leaf's fore-edge, and on the left its ink stops just clear of the end of the body measure.]

f. 26r

[Margin: כו — foliation, two sorts, medial kaf + vav, outer (left) head margin, no geresh]

LI-L6 — close of the chapter running on from the previous leaf.

Its inclination from the equinoctial line of the diurnal sphere is [numeral: ?] degrees [the numeral group reads כ"א/ד] at the sorts — sort 1 is the wide open כ/ב form, so נ is excluded and with it the value 51; sort 2's ceiling is level with its neighbour's, so ל is excluded also. The value is 21 or 24 and is not

settled here. Δ The second sort is the same sort that stands in כ"ד at L3 of this leaf (כל כ"ד שעות, below): L1 and L3 must be read alike, and neither may be settled without the other. The figure is also the same inclination value left open three times on the previous leaf.] and [?] ל[?]ס [?]. And the touching sphere [הגלגל הנוגע], inasmuch as [כיון] ... [?]

whose pole and whose points [שקוטבו ונקודתיו] from the poles of the diurnal sphere ... [?] ... to all the spheres we have written of as moving [להתנועע] ... [?]

every twenty-four hours [כל כ"ד שעות] Δ this ד is the SAME SORT as the open sort in L1's כ"א/ד, measured at matched magnification on this leaf; the two loci must be read alike and neither may be settled alone. See the L1 QA note.]. The measure of [שיעור] ... [?] ... their motion is forward-going [תנועתם קדמיית] [?]. And here the poles of it [הקוטבים שלו] ... [?]

they will be as things moving about the poles of the diurnal sphere [היומי סביב קוטבי גלגל], upon [?] ... [?] ... the diurnal sphere ... [?] and its pole ...

the north. And it revolves about the north pole of the diurnal sphere, and its southern pole [וקוטבו הדרומי] revolves toward the pole ...

[L6 — a short, roughly centred line closing the chapter: a word group read הדרומי, and a second short item to its left ending ... מי with a following double mark. Not resolved.]

**פרק [numeral: ?] **

[Gold display rubric, L7, set at the right margin: פרק in three gold sorts, then a numeral group in gold. One letter body resolves in that group — read as ב, with the Tier-1 hazards כ/ב and ג/ב live — carrying a two-stroke mark above and to its right. Whether a yod stands between the mark and פרק does not resolve at 1:1. The numeral is NOT settled from the chapter sequence. Gold sorts stand about 1.9× the body hand's letter-body height.]

On the exposition [בביאור] [?] — first sort is one of [כ/ב] of the eccentric spheres [הגלגלים היוצאים] [?] — [צ/ד] live in the fourth sort] ... and it has already been explained [וכבר נתבאר] [?] ... that there are in them two kinds [מינים] [?].

For the eccentric sphere [?] of Chamah [the Sun] ... [?]

for the eccentric sphere [כי גלגל היוצא] [?] of Chamah [חמה] [the Sun]; and here the second bearing sphere [והנה הנושא הב'], its name [שמו] — it is the eccentric [?].

[מכל הגלגל] of [ואז/ולא] — not settled] touching [נוגע], from the whole sphere [מכל הגלגל] of [?] ... of Kochav [Mercury] and Levanah [the Moon] [כוכב ולבנה]: they are touching and eccentric [הם נוגעים ויוצאים] [?] ...

כי כל גלגל] for every bearing sphere moves by the motion of the star itself [הנושא מתנועת הככב עצמו], as with Chamah [כמו חמה], or else the bearer moves by the motion of its epicycle sphere [ואו הנושא מתנועת גלגל הקפתו] —

the star, as we said [הככב כמו שאמרנו] [?]. Here it is the more obstructed [?] [הנה הוא יותר מעכב]. And now let us explain what it is, and the sense of "going out from the centre" [ועתה נבאר מהו ... פי' יוצא מרכזו] — for

since the spheres have no voids at all between them [מאחר שהגלגלים אין ביניהם] [הר] יקות כלל ... in all of them [?] — [line-filler dash]

the [?] sphere [הגלגל הק] — its centre goes out from that of its fellow [יצא מרכזו של חבירו] — it is found [נמצא] [?] ... the circumference of the sphere [של מרכזו חבירו ותנועתו] [?] of the centre of its fellow, and its motion [?] they are not [?] joined, [דבוקים שניהם יחד זה בתוך זה] the two of them together, one within the other [ובכל סדרהם].

so it is, then, that the eccentric sphere obstructs [הנה כן כי גלגל היוצא מעכב] [?] ... we have no sphere standing separate by itself [אין לנו גלגל נפרד לעצמו] as it is in every [כמו שהוא בכל]

the spheres that move one within another [הגלגלים המתנועעים זה בתוך זה] ... in all of them [?] it is a sphere set within a division [הוא גלגל נתון תוך מחלקת]

the thickness of the walls of one sphere [עובי דפנותיו של גלגל אחד], for one sphere has [כי יש לגלגל אחד] — and its thickness is divided into two [ובכל עובי גלגל], and in the whole thickness of the sphere [ונחלק עוביו לשנים]

the eccentric is set within two parts of its thickness [היוצא נתון תוך ב' חלקי] upon [?] the eccentric sphere [וקליפתו החיצונית] [עוביו]

and its lower shell conforms to the motion of the sphere [וקליפתו התחתונה] — and the eccentric sphere is found enveloped [מתאמת תנועת הגלגל] [?] [ונמצא גלגל היוצא מלוכש]

[?] it within the thickness of the other sphere [תוך עובי גלגל האחר], and there is no more [ואין עוד] ... other than the other sphere and its two shells [זולתי] [?] sphere [הגלגל האחר וב' קלפיו]

[?] alone [לבד], and [?] the sphere [?], and it clothes [ומלביש] [?] ... [?] the eccentric sphere is [?] [הגלגל היוצא הוא] [numeral: ?]

the stars below [ככבים שלמטן], which have no more than two spheres [אשר] [?] [גלגלים גדולים בלבד] ... great spheres alone [ואין לגלגל] [זולתי ב' גלגלין] uppermost [היותר עליון] with [?] the sphere

the resembling one, and the second, which we have written of, is called the eccentric sphere [הדומה והב' שכתבנו נק' גלגל היוצא] [?] ... [?] the resembling sphere, which in each of them is the one divided [הגלגל הדומה שבכל] [מהם הוא הנחלק]

into two shells [לב' קליפות], and its own eccentric sphere is set between the two sh[ells] [ב' קליפותיו] ... its two shells [קליפות] [?] within them, like the second, the eccentric [כמו הב' היוצא]

all the stars [כל הככבים] — Kochav [Mercury] and Levanah [the Moon] [ככב ולבנה] — whose sphere [?] of them [?] ... they are three great spheres: the resembling, the touching and the eccentric [הדומה והנוגע והיוצא]

as above [כנ"ל], as in chapter [?] [כפ"ב]. And here the name of their resembling sphere [והנה שם הגלגל הדומה שלהם] [?] ... [?] of them is that it is not

[?] in its thickness, and it is not divided into two but rather all [הוא שלא בעוביו] [ואינו נחלק לב' אלא כל]

their touching sphere [הגלגל הנוגע שלהם]; here, the one divided into two shells [הנחלק לב' קליפות] — and within them is set their eccentric sphere [ובתוכם] [נתון הגלגל היוצא שלהם], and there is no [ואין]

difference between the first [?] and the second at all [הראשונה] [כי] [?] the eccentric sphere [הגלגל היוצא] [?] [לשנית כלל] [?] other than [זולתי] [?] for [?] [בכל] [?] ... [?] [?] [?] [?]

[Catchword: 𐤒𐤕/𐤕 — TWO sorts at the foot of the outer (left) end, beneath the last line: a bowl with two arms (𐤕/𐤒, not separated on this ink), then a top bar with a long straight descender well below the baseline (𐤒). Nothing stands between them. See QA.]

f. 26v

within the resembling one [𐤒𐤕/𐤕 recte: תוך] — two sorts on the leaf, not three; the 𐤒 is not inked and is not restored. See QA on the catchword], and the second [והב'] [?] is set within the touching one [נתון תוך הנוגע] — this second occurrence was NOT re-measured and is not covered by the ruling above] [?]. And since this is so [וכיון שהוא כך], there remains [נשאר] [?] the eccentric sphere [גלגל היוצא] [?]

of the [?] [של החתך]; and from its motion you may infer and learn [ותנועתו תקיש ותלמוד] for the rest of the eccentric spheres of the rest of the stars [לשאר הגלגלים היוצאים של שאר הכוכבים].

Know that the resembling sphere of Shemesh [the Sun] [דע כי הגלגל הדומה של השמש] — here it is [הנה הוא] [?] — it is a very thick sphere [הוא גלגל עב מאד], and its thickness is divided into two parts [ונחלק עוביו לב' חלקין] [line-filler dash]

[?] there remain, as it were, three spheres, thin [גלגלים דקים] [שנשארו כמו הם ג' גלגלים דקים], one within the other [זה בתוך זה], and the eccentric sphere set between them [והגלגל היוצא נתון ביניהם] [line-filler dash]

[The figure below is set INTO the text block at the outer (right-hand) side of this verso, and the five lines that follow are shortened and run down beside it. The short measure is layout, not damage and not lost text.]

and [?] [ומתפנ?] [ים] [?] now [עתה], for they are as it were three spheres [כי כמו הם ג' גלגלים]

one within the other [זה בתוך זה], and the centre [ומרכזו] two parts [ב' חלקי] [הגלגל דק] [?] the sphere is thin [מאד דק]

[?] very [?] thin [מאד דק] [?] [?] and the eccentric sphere likewise [וגלגל היוצא כן]

two parts of the resembling sphere, as above [ב' חלקי גלגל הדומה כנ"ל], and the remainder of them [ונשארתם]

they are mixed together [מעורבבים], thin [דק] [?], and there is no difference at all [ואין שום הפך] [ש]

[The short measure continues: lines 10–19 run as a narrow column at the outer edge of the leaf, the plate occupying the rest of the width.]

mixed one with another [מעורבים זה בזה], and there is no difference at all [ואין שום הפ[רש]]

between them. And here, if the resembling sphere [גלגל הדומה] has its thickness divided into two parts [נחלק עוביו לב' חלקים] [?]

[גלגל היוצא] the eccentric sphere [?]

and within the resembling sphere [ובתוך גלגל הדומה] [?]

one centre for the two of them, equal [מרכז א' לשניהם שוה]; but not

is its thickness divided in equal division [נחלק עוביו במחלוקת שוה], but rather they are made of them on a slant [נעשו מהם כאלכסון], for the division — [line-filler dash]

the outer one remains thick on its south side [החיצון נשאר עב מאד דרומן] — [recte: מצד דרומן]; see QA] and very thin

at its north [צפון]; and from the division of its thickness [ומתחלוקת עוביו] [?] it remains thick

very much at its north [צפון] and thin on its south side [ודק מאד דרומן] — [recte: מצד דרומן]; see QA], and thereby there remain [ועי"כ נשארו]

the northern and the southern [הצפוני והדרומי], as is depicted before you [כמצוייר לפניך]. And since the resembling sphere is divided in this way, it must be that the sphere [וכיון שהגלגל הדומה שנחלק כך מוכרח הוא שהגלגל]

eccentric revolves and rolls [היוצא יסובב ויתגלגל] through [?] [?] ... [?] [?] that one will be more divided at the north of the equinoctial line [ההוא יהיה יותר מ[ת]חלקת בצפון קו השווה]

of the resembling sphere, and its motion is toward its south [של הגלגל הדומה] ... its centre will be eccentric, close to the north of the centre of the sphere [מרכזו יהיה יוצא קרוב לצפון המרכז של הגלגל]

the resembling one, as is depicted before you [הדומה כמצוייר לפניך], how it stands upon the meridian line [ואיך הוא על קו חצי היום] [?] ... [?] but that it is to the north of the equinoctial line of [אלא שהוא לצפון הקו השווה של] — [line-filler dash]

to the south and not to the north [הדרום ולא לצפון], or [?] and not to the south, and not [ולא לדרום ולא] ... and not above the centre and not below it, but rather [ולא למעלה מן המרכז ולא למטה ממנו אלא]

to its north [לצפון]. Moreover, the star Shemesh [the Sun] [ועוד ככב השמש] — here it is fixed on the line [הנה הוא קבוע בקו] [?] ... the equinoctial line of this eccentric sphere, as we said [קו השווה של זה הגלגל היוצא כמו שאמרנו] [?]

of the thickness [?] of Shemesh, the measure of the thickness of the wall of the eccentric sphere [של עובי] [?] ... [?] of Shemesh [גלגל השמש]. Moreover, I have shown you [?] by this [גם הכרחיתך בזאת] [?] the resembling sphere [גלגל הדומה]

of Shemesh — here it is directed in all its aspects [?] toward the sphere [של] ... of degrees [המעלות]; and therefore it is called "resembling," for it resembles the sphere [ולכן נק' דומה כי הוא דומה אל גלגל]

of degrees [המעלות]; but the eccentric sphere thrusts its centre out from among them [אבל גלגל היוצא ידחה מרכזו מתוכם] ... the centre of the sphere of degrees; and therefore it is called the eccentric sphere [מרכז גלגל המעלות ולכן נק'] [גלגל היוצא]. And here, since [והנה כי]

Diagram. A set of concentric circles set into the text block on f. 26v, occupying roughly the lower two-thirds of the leaf's width and standing beside lines 5–19, which run shortened down the outer edge. The outermost circle is broad enough that the plate is wider than the writing block.

Colours actually present: gold and blue, with the lettering in the body's brown-black ink. No red anywhere on this plate. The gold does the whole construction — every circle, both diameters, the radial partitions and one wide cross-hatched band. The blue is a single circle, the innermost one drawn, laid in as an opaque stroke of even width; it is a drawn element of the construction, not a border ruling.

Construction, stroke by stroke, from the centre outward:

- Two gold diameters cross at the centre, one vertical and one horizontal, and run out through every ring to the outermost circle.
- The blue circle is the innermost. The words מרכז הארץ — the centre of the earth — stand inside it, written along the horizontal, in the quadrant to the right of the vertical diameter as the reader faces the page. This label is secure sort by sort.
- Outside the blue circle, a gold circle, then a broad gold band filled with a continuous cross-hatched (lattice) fill — the one band on the plate that is filled rather than outlined. It is crossed by short radial gold ties.
- Outside that, two further plain gold circles enclosing a narrow annulus, which is divided into compartments by short radial gold bars; each compartment carries a word.
- The outermost circle is plain gold. Four word-groups stand at the ends of the two diameters, outside it.

Labels READ (position, then reading):

- centre, inside the blue circle: מרכז הארץ — the centre of the earth. Secure.
- top, outside the outermost circle, on the vertical diameter: מעלה — above. Four sorts; תעלה is not excluded on the first sort (the Tier-2 מ/ת pair), and the sense of the neighbouring prose (ולא למעלה מן המרכז ולא למטה ממנו) is not being used to settle it.
- left of centre, on a ring at radius ≈ 620 : קוטבי ה — קוטבי (poles of) is secure; the second word is four sorts whose first is the standing ה-with-dropped-leg / ק ambiguity, giving קיום or היום. Not settled.
- upper left, radius ≈ 645 , two word-groups on one arc: [רומן] and שפל. Both are apsidal vocabulary (perigee, its apogee); whether they are one label or two was not determined.
- upper left, set radially at radius ≈ 600 : גלגל ראשון — first sphere. Read on fig2_p6; ראשון is five sorts and separates.

- above it, set radially: a two-word group read **שבתי דומה** [?] — if right, Shabtai [Saturn], resembling. Flagged: **שבתי** here is exactly the word the surrounding subject matter would supply, and the second word's first sort carries the **ד/ר** pair.
- right of centre, above the horizontal diameter at radius ≈ 540 : **ד[רומ]** — five sorts. Whether the leading sort is a dalet (giving its south) or the word is **רומ** (its apogee) did not resolve, and the two readings pull in different directions.

Labels NOT read — census by position, with sort counts:

- upper left, on the compartmented annulus (radius ≈ 856): four sorts, read **מערכ** on fig2_p3. Not committed; see the conflict with the bottom label below.
- top left of the vertical diameter, on the annulus (radius ≈ 857): five to six sorts. Read **תחתנים** on fig2_p3 and **מאזנים** on p2_p2 — the same object, read two different ways at the same magnification. **תאומים** also fits the ductus. NOT settled, and the fact that two passes disagree is the finding.
- top right of the vertical diameter, on the annulus: five sorts, read **בתולה**. First sort carries the **כ/ב** pair. Not settled.
- left, on the outermost circle, set vertically: four sorts, read **דרום**.
- left, radius ≈ 880 : three sorts, read **דרך**.
- lower left, radius ≈ 845 : four to five sorts, did not separate.
- bottom, on the vertical diameter outside the outermost circle (radius ≈ 940): four sorts, read **מערכ**. This contradicts the upper-left label, which reads the same way — one of the two is wrong, and I cannot say which. If the four cardinal-position labels are **מטה / מעלה** / and a pair, the bottom one should be three sorts, and it is not. Reported as a conflict, not resolved.
- right, on the horizontal diameter outside the outermost circle (radius ≈ 924): three to four sorts, set vertically. Did not separate.
- lower right, curved along an inner ring: three word-groups, of which only the last gave anything (**דרומ**). Did not separate.
- right, set radially at radius ≈ 400 – 500 : two word-groups opening **גלגל ה**.... The completion did not resolve.

f. 27r

[Margin: **כו** — foliation, two sorts, medial kaf + zayin, outer (left) head margin, level with the running header, no geresh.]

L1–L5.

The measure of the thickness of the two [?] of the resembling sphere **שיעור** [שוין זה כזה]; and likewise the measure of the thinness of each one of them **וכן שיעור הדקות של כל חד מהם** [הם שוים זה עם זה] — they are equal to one another [הם שוים זה עם זה].

Know further [גם דע] that at the place of the small pole [?] [כי במקום ה[?] הקטן] of the resembling sphere, which stands opposite the point that is in every [?] ... [שהוא כנוכח הנקו' שבכל]

[?] the meridian line [קו חצי היום] ... the small [?] ... one, the north side [?] — and here the place aligned [והנה המקום המכוון] opposite [?] the point [נקו'] ...

[?] the sphere of degrees [גלגל המעלות]; there is the extreme of thinness [?] ... of the resembling sphere, and opposite [?] ... [שם תכלית דקות]

there is the extreme of thickness [שם תכלית עובי] ... [?] ... of the resembling sphere. And here this small [?] [והנה זה ה[?] הקטן] of the sphere ...

L6–L14.

the resembling [sphere] of Shemesh [the Sun] [הדומה של השמש] is [?] ... [?] and therefore, like the motions of the sphere [ולכן כתנועות גלגל] which encompass it [המקיפים עליו], and that which [ואשר] ...

there is the extreme of thinness of the small sphere [שם הוא תכלית דקות] and it emerges that when the diurnal sphere revolves [כי] [והגלגל הקטן] [בהיות גלגל היומי מתגלגל], so also do the two parts of the resembling sphere — [כן ב' חלקי גלגל הדומה]

And now the star of Shemesh is fixed in it, as mentioned [והנה עתה ככב השמש] [קבוע בו כנו'] with [?] Shemesh by the motion of the diurnal sphere [ובזהיות מ[?] נוגע ע[ם/ת] השמש ע"י תנועת גלגל היומי] toward [?] ...

the point that is the more [?] [הנקו' היותר ק], which stands opposite [?] the small [?] [ה[?] הקטן] [שהיא כנוכח] the head [?] [אשר מכוונת כנגד] ... as mentioned [כנו'].

Here, [אז "then" / לא "not" — NOT settled, the two sorts do not separate], Shemesh is distant by the utmost of distance [השמש מרוחק תכלית ההרחק] from the [?] of the part [מ[?] החלק]; and the measure of this utmost distance already mentioned [ושיעור תכלית המרחק הזה הנז']

is as the measure of the [?] of its centre [כשיעור [?] מרכזו] and the [?] ... [?] ... the resembling sphere. And this point [והנקו' הזאת] [?] with the apogee [?] of Shemesh [רום השמש]; and when [וכאשר]

the eccentric sphere [?] revolves [יסובב גלגל היוצא], and the inclination [?] [עד נקו' הדרומית] ... [?] ... of Shemesh, as far as the southern point [שהיא תכלית עובי דופן] which is the extreme of the thickness of the wall

of the part of the resembling sphere [חלקו של הגלגל הדומה], the motions [?] [אל [?] החלק] this. Here, [אז / לא — NOT settled], it is near at the utmost of nearness [הוא קרוב בתכלית הקירוב] to the [?] of the part [החלק]

and this point is [?] the perigee [and] apogee of Shemesh [שפל [?] [?] והנקו' ה[?] [?] [שפל] [הקודם] ... [?] the preceding [?] ... twice [ב' פעמים] Shemesh ...

L15–L25.

[?] as the small points [כנקו' הקטנות] [?] and the southern [?] [והדרומית] ... so that you may understand [שתבינ] [?] their matter thus [כן ענינם] : And

know that this point — the small ones [ודע כי זו הנק' הקטנות] — they call it [יקראוה]

the [?] [ה[?]]ים], the apogee of Shemesh [רום השמש], or the height [?] of Shemesh [או ג/ע]ובה השמש], or the far distance of Shemesh [או מרחק השמש הרחוק]; and the southern point that is in the sphere [והנק' הדרומית שבגלגל]

of the resembling [sphere] — they call it the perigee, the apogee of Shemesh [הדומה יקראוה שפל רום השמש], or the perigee of Shemesh [או שפל השמש], or the near distance of Shemesh [או מרחק השמש הקרוב]; and since this [זה כי זה]

resembling sphere is set opposite the sphere of degrees [גלגל הדומה הוא מכוון] [וישיעור מהלכם שוים] and the measure of their course is equal [כנגד גלגל המעלות], therefore the small points, together with the head of [לכן הנק' הקטנות עם ראש]

[?] ... the point of the [?] [נק' המעל[?]]ית] and the [?] [והתנוע[?]]ית] — which are at the place where the equinoctial line of the resembling sphere meets [הקטנה] [?] ... the small [?] [שהם במקום שפוגש קו השווה של הגלגל הדומה] and [?] ... [?]

set opposite the head of Aries and the head of Libra [?] [מכוונים כנגד ראש] [או] — NOT settled] it has neither apogee nor perigee [אין לו לא רום ולא שפלות]; and when it is like the rest of the places [ובהיותו כשאר המקומות]

of the sphere, the apogee and the perigee [הרום והשפלות] [או] — NOT settled] change in them [ישתנה בהם] according to their distance from the equinoctial line of the resembling sphere [כפי מרחקם מן קו השווה של] [הגלגל הדומה] toward [?] —

or toward its south [או לדרומו]. And it emerges that when Shemesh is in the half [?] of its sphere [ונמצא כי בהיות השמש במחצ[?]]ית גלגלו] on the side of its apogee [לצד רומו], its course [מהלכו] [או] — NOT settled] be opposite the sphere

of degrees [גלגל המעלות] ... [?] one [?] more than [?] in its sphere [בגלגלו], and [?] this [?] its nearness to the earth [קירובו אל הארץ], and [?] according to [כפי] —

as the course of the southern [?] and the middle [?] [כמהלך הדרומית והאמצעי] [?] : And here [?] the going-out of the centre of the eccentric sphere of Shemesh [יצאת מרכז גלגל היוצא של השמש] is like [?] ...

L26–L28 (the last written lines of the side).

to the north, before the head of [?] [לצפון לפני ראש]; and it has already been [?] [?] [?] that the sphere of degrees — its equinoctial line is inclined toward the north and inclines [כי גלגל המעלות הקו השווה שלו נטוי כלפי צפון ונוטה]

[?] the equinoctial line of the sphere of degrees [הקו השווה של המעלות] [?] opposite [כנגד]; and there, when it is [numeral: ?] degrees [ומן בהיותו] [?] [עד מרחקו הרחוק] from [?] as far as its far distance [מעלות ?]

and the point of the apogee of Shemesh [ונק' רום השמש]; and opposite this, when it is [numeral: ?] degrees [וכנגד זה בהיותו] [?] [מעלות ?] from that

which is set opposite [?] [מן זה שהוא המכוון כנגד] — for there is between them [כי יש ביניהם]

f. 27v

L1–L8.

[numeral: ?] whole degrees [מעלות שלמים], which is [?] from the line [?] of the sphere [?]; and there it is called its near distance [מרחקו הקרוב ... ושם נק' ...], and it is called the perigee of its apogee [ונק' שפל רומן]. And here [?] as has been explained [והנה [?] שנתבאר]

the eccentric sphere of Shemesh [the Sun] [גלגל היוצא של השמש], how [?] ... [?] so too the two [?] [כן ב'] ... the extreme of the thickness of the resembling sphere [תכלית עובי גלגל הדומה]. So it is in all the spheres [בכל הגלגלים] —

the eccentrics of the rest of the planets [היוצאים של שאר ככבי לכת] for [?] ... [?] stars [?] ... [?] which we said [?]: it is set inside the resembling sphere [הוא נתון בתוך גלגל הדומה], for every —

Kochav [Mercury] and Levanah [the Moon] [ככב ולבנה]: their eccentric sphere is [?] only [אלא [?] אלא] inside their second sphere [נק' הדומה], which is called the resembling [הוא נתון בתוך גלגל הדומה], and it is the [?] [?] as far as [?] the resembling sphere [גלגל הדומה] of the [numeral: ?] stars [של ה] ככבים —

whole [שלמים]: And now let us explain [ונבאר עתה] [?] the revolution [?] [?] [הנה הקפ] [?] between Shemesh and the [numeral: ?] stars [בין השמש אל ה] ככבים —

the sages who said [?] [החכמים שאמרו] this: that Shemesh has no small epicycle sphere [כי השמש אין לו גלגל הקפה קטן], and therefore it has no apogee at all [?] [ושפל רום] [?] and the perigee of the apogee [?] [ולכן אין לו רום כלל] —

the eccentric sphere for Chamah [the Sun] [גלגל היוצא לחמה] ... [numeral: ?] stars [?] [?] ... [?] they have two apogees and two perigees [יש להם ב' רומים וב' שפלים], like the first [?] [כמו הראשון], in the sphere [?] —

L9–L22.

the eccentric [היוצא] [?] like Shemesh [?] [כשמש] [?] the revolution [?] [?] ... [?] their circuit [הקפתם] [?] ... And it emerges that when some star [ונמצא כי בהיות איזה ככב] [?] at the apogee of both of them [ברום שניהם], the course will be the later [יהיה מאוחר המהלך] [?]; and when they are, the one at the apogee and the other at the perigee [וכהיותן ברום הא' בשפל האחר] [?] — NOT settled

it will be delayed [יתאחר] [?]; and when they are both at the perigee [וימהר] [?] ... and their circuit [והקפתם], which is so for Kochav [Mercury] and Levanah [the Moon] [ככב ולבנה], toward [?] —

stars [?] [?] ... [?] for their eccentric sphere [כי גלגלם היוצא] [?] stars [?] ... [?] are set within the two parts of their sphere [נתונים תוך ב' חלקי גלגלם] —

the resembling [הדומה]; and two stars, Kochav [Mercury] and Levanah [the Moon] — [וב' ככבים ככב ולבנה] [גלגלם היוצא] [?] is only set within the two parts of their touching sphere [תוך ב' חלקי גלגלם]; and that which [ואשר] [הנוגע];

moving [?] toward them [מתנועעים אליהם] [?], and on the side of the epicycles [?] [ומצד ההקפות] there follows further [נמשך עוד] [?] ... [?] a circuit and another variation [הקפת ושינוי אחר]; and here, the eccentric spheres [והנה כי הגלגלים היוצאים] —

[?] which we said [?] [שאמרנו], the order of their motion [סדר תנועתם] is from above downward [מן המעלה אל המטה] [?], on the side of the motion of their resembling spheres [כמצד תנועת גלגליהם הדומים]; and therefore [ולכן]

their centre is not [?] [אין מרכזן], the eccentric spheres move [הגלגלים היוצאים מתנועעים] [?] ... [?] and [?] if the spheres move [?] [הנה הם], here they are [אם הגלגלים מתנועעו]

moving upon [?] [מתנועעים על] [?] centres [מרכזים], and their courses [ומהלכיהם] [?] — they are fixed [?] [הם קיימים]; however, the eccentric spheres of Kochav [Mercury] and Levanah [the Moon] [אמנם גלגליו היוצא של ככב ולבנה]

since they are intermixed and set within the two parts of the sphere [להיותם] spheres; and here their motion is contrary to their spheres [והנה תנועתם הפכיית אל גלגליהם] [?] ... [?] [מעורבבים ונתונים תוך ב' חלקי גלגל]

[?] for [numeral: ?] [?] their spheres, the touching [?] [הנוגע], moves [?] [מתנועע] ... [?] upward [למעלה]; and their eccentric spheres move upward [וגלגליהם היוצאים מתנועעים למעלה]

and since they are set within the two parts of the touching sphere [וכיון שהם] [התנועה הא'], they are compelled to move [נתונים תוך ב' חלקי הגלגל הנוגע] [?] the first motion [?] [תנועה] [מוכרחים להתנועע] [?] a motion

the stellar [?] [הככבית] [?] their motion [תנועתם] [?] ... [?] — see the QA note on a possible chapter cross-reference] ... and here their centre [?] [והנה מרכזם], the eccentric [היוצא], is rolled by [?] the touching sphere [ולכן] [מתגלגל ... הגלגל הנוגע]

when they move with the contrary motion [בהיותם מתנועעים] [התנועה ההפכיית], the stellar epicycle [?] [ההקפה הככבית] [?] — the centre of the eccentric sphere will move [?] [יתנועעו] [מרכז גלגל היוצא] ...

L23–L28 (the last written lines of the side).

the centre of the touching [spheres] [?] [מרכז הנוגעים], whose centre is the centre of the part [?] [אשר מרכזו מרכז החלק] [?] ... [?] small [קטנה], the measure of its thickness [שיעור עביו] twofold [?] [כפלים]

as the measure of the going-out of the centre of the eccentric sphere [כשיעור] [מרכז גלגל הנוגע] [?] [יציאת מרכז גלגל היוצא] from [?] the centre of the touching sphere [?] [כמו שאמר] [לך] [?] [הקודם] [?] the preceding [?] [?] told you [?] [?] is the centre of the touching sphere [ונאמר] [?] [?] is the centre of the eccentric sphere [כי אות א' היא מרכז גלגל הנוגע] [?] [היא מרכז גלגל היוצא] [?] that —

since [?] inverts [כיוון שמתהפך] upward [למעלה] [?] the small [?] its motion, the resembling [?] ... [?] it will invert its eccentric centre also [יהפך גם את מרכזו היוצא] together with [?]

[?] and the eccentric centre revolves [ויסובב מרכז היוצא] by way of [?] ... [?] the motion is very small [?] [התנועה קטנה ממש] upon the centre of the touching sphere [על מרכז גלגל הנוגע]

[?] [?] and it moves [?]; and it emerges that the centres of the eccentric sphere of Kochav [Mercury] and Levanah [the Moon] [ונמצא כי מרכזי גלגל היוצא] [הם קיימים] — [של כבב ולבנה] are fixed

f. 28r

[Margin: כח — foliation, two sorts, medial kaf + chet, outer (left) head margin, level with the running header, no geresheh. Continues the ff. 21r–27r medial-kaf run; not f. 20r's final ך.]

L1–L5.

(Opening word, read on its own evidence: six sorts, [ב/כ/מקומם] — the first sort is one of the Tier-1 כ/ב pair and does not separate. f. 27v's catchword was recorded as [ב/כ/מקומם], so the two agree in every sort and disagree in none, the same one being unresolved on both leaves.)

in their places [ב/כ/מקומם] [?] ... they are in motion [הם מתנועעים] and revolve a revolution [?] [ומסבבים] [ס/יכוב] [about] the centre [מרכז]

of the touching sphere [?] / of Nogah [Venus] [?] [וגלגל הנוגע/ה] ... [?] ... in the manner of the poles of [כענין קוטבים של] ...

so it too [גם הוא] revolves around [מסביב] the poles [והקוטבי] of the sphere [של גלגל] ...

the diurnal [sphere] [היומי]. And this is because the place [מקום] [?] ... [?] of the [?]—many planets [של ?' ככבי לכת] —

they stand opposite the equinoctial line of the sphere of degrees [הם כנגד קו] ... [ולא יטו] ... [השוה של גלגל המעלות]

L6–L15.

neither to the north nor to the south nor to any other of the places [לא לצפון] ... [ולא לדרום ולא לשאר מקומות]

the sphere. Rather, it is set opposite the equinoctial line of the sphere [הגלגל] ... [אלא הוא מכוון כנגד הקו השווה של גלגל]

of degrees [המעלות] ... [?] ... for the equinoctial line of the [sphere of] degrees [כי קו השווה של המעלות]

is inclined toward north and south of the equinoctial line of the [?] [נטוי הוא] ... [כלפי צפון ודרום של קו השווה של ה]

as stated above [כנ"ל]. And we shall now set out the measure of the [?] and the remainder of the [?] [ונבאר עתה שיעור ה?] [ו]שאר ה] ...

of the stars, and so on [הככבים וכו']; [?] the measure of the thickness of each of their resembling spheres [שיעור עובי] כל גלגל הדומה שלהם. And we shall begin with determining the centre of Shemesh [the Sun] [ונתחיל בדיעת מרכזו של השמש].

We have already premised [?] [הנה הקדמנו] that the eccentric sphere [גלגל היוצא] ... [?] ... is itself divided into [?] [נחלק גם הוא ל] degrees; and in the sphere of degrees, which are divided into [?] [מעלות בגלגל המעלות הנחלקים] — [?]על כ

parts [חלקים], and you shall add [?] [ויתחב]: take seven parts of them [תקח ז' חלקים מהם] and they will be 10[?] degrees and a half [ויהיו ק"ד מעלות וחצי]. And this is the measure of the diameter [?] of the eccentric sphere [זוהו הוא שיעור קוטן גלגל היוצא] —

the whole thickness of the sphere in a straight line [כל עובי הגלגל בקו ישר]; and it is displaced from here onward and upward [ונועתק מעתה ולמעלה] ... [?] ... as stated above [כנ"ל], as in chapter [?] [כפ"י] ... [?] ... everything that has in its circumference [?] three [?], has [כל שיש ב]היקפו ג' [?] יש ...

as is known [כנודע] ... [?] ... and the [?] is seven parts from the star [והש?] [הוא ז' חלקים מן הככב] ... and here, opposite [והנה כנגד] [?] ... [?] degrees and a half [מעלות וחצי] ...

LI6–L25.

now [?] the aforementioned [הנז'], and a half; and the remainder is [?] degrees [מ'פ' מעלות] — 60 or 80, not separated; the same sort stands at L17 below and the two must be read alike]. And here [?] ... [?] its centre, that of Shemesh [the Sun] [מרכזו של השמש] — they are a measure of [?] degrees [הם שיעור מ'פ' מעלות] — the same sort as LI6's, measured; not the כ/ב class]

and a half, approximately [וחצי בקירוב]; the motions [תנועות] [?] ... degrees [מעלות] ... [?] ... a part of the diameter [?] of the sphere, as mentioned [שהם קטנות תנועה], which are small [?] in motion [מתנועע] ...

the motions of the sphere [התנועות של הגלגל], and the measure of the distance [?] [ושיעור ר]חק is the utmost [?] [הוא תכלית ה] ... [?] ... the distance of Shemesh, which is displaced from the centre [מרחק השמש המעתק] מן המרכז, when it is [בהיותו] ...

as is known [כמו שנודע], the distance [מרחק] [?] ... [?] its sphere, as stated above [גלגלו כנ"ל] ... [?] from the thickness [ומעובי] ... [?] ... the centre of Shabtai [Saturn], as mentioned, three parts and a sixth [?] of a part [מרכז שבתאי] ... [ובכיוצא] ...

a part of ten [?] parts [חלקי] [חלק מעשר] of half the diameter [?] of its eccentric sphere [?] [נחצי קוטן גלגלו היוצא], according to what was said above [וע"ד הנ"ל] ... [?] as mentioned, like Shemesh [הנז' כשמש]; and Tzedek [Jupiter], as mentioned, 28 [?] and a half [וחצי] [נח] [וידק הנז' כ"]; and likewise from [ובכיוצא מן] .

the aforementioned parts [החלקים הנז']; and Nogah [Venus], one part [ונוגה חלק א'], and likewise [?] of them [וכנ"ב יוצא] מהם; and Kochav [Mercury] [וככב] ... Kochav, 50 [?] parts, as mentioned [וככב] [הנז' חלקים הנז']; and Levanah [the Moon], 12 [?] parts [מלכנה י"ב חלקים], from the centre [מנה מרכזן]

the star [?] [הככב] [Scribal collation note: "א' י' מעלות וכ' חלקים — an alternative reading, "another version: [?]10 degrees and [?]20 parts". Apparatus,

not text; both numerals flagged.) ... [?] ... and it seems to me [?] [ונלע"ד] that in each one [שככל א'] ... [?] the measure of the emergence [?] [שיעור יצואת] [מרכז גלגל היוצא של השמש] of Shemesh [?] the centre of the eccentric sphere [?] toward the north side [לצד צפון], set opposite [?] [מכוון] ... [?] ... the centre of the world, as mentioned, 20 [?] parts and a half, approximately [מרכז העולם הנו] [כ' חלקים וחצי בקירוב]

And this same measure, as mentioned [וזה] [השיעור עצמו הנו], is the measure of the parts of the thickness of each one [שיעור חלקי עובי כל אחד] ... [?] · [?] its resembling sphere [גלגל הדומה שלו] "

[NOT SETTLED] ב/ג"פ פרק י

(Chapter rubric, in gold, at f. 28r L25 — see the QA note below. The chapter's opening words run on the same line, to the left of the rubric.)

[?] ... [?] its motion [תנועתו], and in every sphere [?] [ובכל גלגל] ... [?] ... and a sphere, and the measure of its motion [ושיעור תנועתו], and the diurnal sphere [וגלגל היומי], the aforementioned [הנני] ...

L26–L28.

its motion upward [?] [תנועתה למעלה] ... [?] ... so [?] the sphere [גלגל] — the resembling sphere [גלגל הדומה] [?] resembles, in all its quarters [?] [בכל פא/ת/תיו] [כדור הארץ];

they are, as regards its centre and its pole and its [?] lines [הם כענין מרכזו וקוטבו] [שכלם] מכוונים עם מרכזו וקוטביו וקוים של כדור [ו] [ב/ג"פ] קוים שלו

of the earth [הארץ]. And by the ordering [?] of its motion [ומנסדר תנועתו] it is displaced upward [היא מתעלת] [ק למעלה] ... [?] ... and the measure of its motion is one complete revolution in 2 [?] [ד] [שלם בכ"ד]

Diagram. (This figure stands at the head of f. 28r, occupying the left two-thirds of the writing block beside L1–L10. It is appended here rather than interleaved above because the page's text was committed to disk before the plate was read, and committed text is not rewritten.)

Colours actually present: gold, red-orange AND blue — all three. Nothing on this plate is in a fourth colour; the labels are in the body's black-brown iron-gall ink, not in gold.

Construction, stroke by stroke. Three concentric circles, drawn one inside the other about a common centre:

- the outermost circle in gold, the largest of the three and the measure against which the two inside it are described below;
- a middle circle in red-orange, roughly concentric, its radius roughly two-thirds to three-quarters of the gold circle's — approximate, because the stroke is broad and I did not measure it against a rule;
- an innermost circle in blue, its radius roughly a quarter of the gold circle's.

Across them run three straight gold lines and no others:

- one horizontal line at $y \approx 1519$, running the full width of the gold circle and projecting a little beyond it on the west, where a black label stands at its end;
- two vertical lines, both running the full height of the gold circle, at $x \approx 1690$ and $x \approx 1888$ — parallel to each other and roughly a seventh of the gold circle's diameter apart, so only one of the two can pass through its centre.

There is no shading, no arc-segment, no arrowhead and no second figure on this side.

Labels read:

- א (inside the blue circle, just below the horizontal line) — one sort, unambiguous.
- ב (inside the blue circle, just below the horizontal line, east of א and beyond the first vertical) — one sort, unambiguous.
- מרכז ("centre") — four sorts, written rotated, in the north-east region between the blue and gold circles.
- יוצא ("emerging / eccentric") — four sorts, rotated, immediately east of the preceding. Reported as two adjacent groups rather than as one phrase, because I cannot see whether a definite article stands between them.
- גלגל היוצא ("the eccentric sphere") — rotated, north-west region.
- מש[?] — three sorts, at the west end of the horizontal line, outside the gold circle. First two sorts מ, ש; the third does not resolve (final kaf / final nun / a he with an extended stroke are all live). This label stands so far out toward the fore-edge that it is clipped or crowded out by the body cut; it is legible only on the wider plate cut.

Labels NOT read — by position, with sort counts:

- North-west, immediately east of גלגל היוצא: a rotated two-word label, first word 5 sorts with the impression תנועת ("motion of"), second word ≈ 4 sorts, not read.
 - Inside the blue circle, above the horizontal line: a two-line label. The upper line is 4 sorts with the impression אמצע ("middle"); the lower line is ≈ 4 sorts and is not read. Neither line is committed.
 - East of the gold circle, at the level of the horizontal line: a rotated group of $\approx 3-4$ sorts, not read.
 - East of the gold circle, below the preceding: a rotated group of $\approx 8-9$ sorts in two words, not read.
- more than two labels carry unread sorts.

f. 28v

L1–L9.

(The side opens on שעות — the word f. 28r's catchword announced — completing the previous line's בכת"ך.)

hours [שעות], which are its day and its night [?] [שהם יומו ולילו]; and with it [ועמו] the sphere of degrees [גלגל המעלות] ... [?] ... it too, likewise: the resembling sphere [גם הוא כן גלגל הדומה] [?] its centre is the centre [מרכזו מרכז] of the earth [הארץ], in its form [לתמונה] — its poles and its two [?] lines [קוטביו וב' קוים שלו], which are the equinoctial line and the cutting line [שהם קו השווה וקו החותך]; they touch [הם נוגעים] the poles [?] and the lines of [מן קוטבי וקוי] —

the globe of the earth [כדור הארץ]. And by the ordering [?] of its motion [ומן] it is displaced [מתעתק] upward [?] [למעלה] ... [?] ... the reverse of the [?] sphere [הפך גלגל היותו]; and the measure of its motion is one revolution [ושיעור תנועתו סיבוב]

complete [שלם], in thirty-six thousand years [כל"ו אלף שנה] — 36; the ו has no leftward head-bar, so ז (37) is excluded], which is a degree [?] in a hundred years [שנה] — the rate-sort is ק, its descender running well below the baseline; the מעלה numeral is NOT read — formally [ל/א], 1 or 30 ... [?] ... years [שנים], and [?] — their complete revolution [סיבובם שלם] in [?] thousand years [אלף שנים] — this second thousands-numeral was NOT probed and stays unread] —

which is a degree [?] in seventy years, approximately [ל/א] — שהוא מעלה [ל/א] — the rate-sort is a two-armed ע with both feet on the baseline and no descender of any kind; ק is refused by the ink against this line's own ק of בקירוב. △ This rate does NOT agree with L4's hundred and must not be harmonised with it — see QA. The מעלה numeral is NOT read: formally [ל/א] · And before [?] [ו] ... [?] ... who began with three stars [?] [לכתוב מה שראיתי], to write down what I have seen [שהתחיל בג' ככבים]

it is written [?] [כתוב] that the apogees of the stars [רומי הככבים] are fixed and do not [?] move [הם קיימים ולא ינועו] ... [?] ... are in motion [מתנועעים], according to the view of the author of the [?] [התמונה] [כפי דעת בעל], the whole [הכל]

the later authorities all agreed [האחרונים כלם הסכימו] that they are in motion [שהם מתנועעי] ... [?] ... except that there is a dispute among them on this point [כי] —

their motion is like the motion of the constellations [?] [תנועתם כתנועת המזלות]: a degree [?] in every [ל/א] — מעלה [ל/א] — the numeral sort is unread; see the L4–L5 QA] ... [?] ... every 40 [?] years [בכל מ' שנה], and it became clear [?] [ונתגלה] that, as regards Shemesh [the Sun] [כי לפי השמש] ... [?] ... globe [כדור] [?] ... and south, like the southern [וידרום כדרום] [?] the sphere [גלגל] [?] a degree [?] from the whole [מן הכלל] [מעלה [?] ...

L10–L22.

And some say [וי"א] that the apogee of Shemesh [רום השמש] is in motion, a motion [?] [מתנועע תנועה] ... [?] ... added to it [נוסף עליו], and it is a degree [?] in every [?] years [שנים] [ל/א] — והוא מעלה [ל/א] — the numeral sort is unread; see the L4–L5 QA] —

and it emerges that when the [?] motions are combined [נמצא כי כשהתחבר] the motion of the south [?] ... [?] ... [שהם] the motion of the south [?] ... [?] ... [מעלתו ותנועתו] its degree and its motion [תנועת הדרום]

it will be one degree in [?] years [יהיה מעלה א' כמו?] שנים] · As I have written [שכתבתי], it has a sphere [יש לו גלגל] ... [?] ... the resembling sphere; for the resembling [sphere] of the sphere of degrees, according to its motion [גלגל] הדומה כי הדומה של גלגל המעלות כפי תנועתו

diminishes [?] in its form [מתמעט לתמונה], and the measure of its motion is a degree [?] ... [?] ... one degree in every year, approximately [מתנועע] [אבל הוא נוגע], moving [ומכשעור תנועתו מעלה א']

and its poles, and the equinoctial line and its cutting line [וקוטביו וקו השווה] ... [?] ... is known from its centre [ומן מרכזו]; and therefore the sphere too [ולכן גם גלגל] the form [התמונה]

as stated above, as in chapter [?] [כנ"ל כפ']; and the small [?] sphere [?] is completed [וישלים גלגל] between the two small [?] [בין ב' קטני] thickness [ועובי] ... [?] ... the thickness of the resembling sphere; and likewise the sphere [עובי גלגל הדומה וכן גלגל] a centre, and this is the carrier [מרכזו וזה נושא]

and small [ויקטנה]; and in all its quarters it resembles the resembling sphere [ובכל פאתיו דומה אל גלגל הדומה] ... [?] ... thus the sphere [boxed word] — its degree and the measure of its motion, for this [מעלתו וכשעור תנועתו כי זה]

it moves each day two [?] parts, and in a year [?] one degree [מתנועע בכל יום] ... [?] ... its resembling sphere, and likewise a carrier, for it carries [גלגלו הדומה וכן נושא כי הוא נושא] the [?]

[?] its small sphere, that of the epicycle [גלגלו הקטן של ההקפה], in which is fixed [שבו קבוע] ... [?] ... as I have written; and also what [מה] [שכתבתי וגם מה] — the small sphere of the epicycle [הגלגל הקטן של ההקפה]

[?] resembles, in all its quarters, its resembling sphere, and that of its eccentric sphere [דומה בכל פאתיו אל גלגלו הדומה ושל גלגלו היוצא] ... [?] ... the eccentric, from the sphere [?], and the measure of its motion, for what [?] the motions [ומכשעור תנועתו כי מה תנועות]

three parts each day [ג' חלקים בכל יום], divided [מתחלק] · its own small sphere [גלגלו עצמו הקטן] ... [?] ... the small one; and it also touches a second [מגלגל] [וגם שהוא נוגע עוד שנייה], one [אחת], from the sphere [?]

[?] its eccentric sphere, as stated above, chapter [?] [היוצא כנ"ל פ] " [?] [גלגל דומה ו?] בכל פאתיו אל גלגל] — [?] in all its quarters, to the sphere [גלגל דומה ו?] בכל פאתיו אל גלגל]

the resembling [sphere] of [?] [הדומה של], as I have written [?], and the sphere [וגלגל] [?] the eccentric sphere [גלגל היוצא]; and it too [וגם] ... [?] ... it too resembles, in all its quarters, the eccentric sphere of [?], as I have written [גם הוא דומה בכל פאתיו לגלגל יוצא של] [שכתבתי]

L23–L28.

its degree [מעלתו], and the measure of its motion, for what [?] moves each [בכל] ... each day five parts less a second [?] ... [וכשיעור תנועתו כי מה מתנועע בכל] [?] [יום ה' חלקים פחות שניה] [וגלגלו הקטן]

of the epicycle [של ההקפה]; and here the resembling [sphere] belonging to the epicycle sphere of [גם הנה הדומה לגלגל ההקפה של] ... [?] ... of, as I have written [של שכתבתי], its degree [מעלתו], and the measure of its motion, which is 54 [?] [וכשיעור תנועתו שהם נ"ד]

parts each day [חלקים בכל יום] " Ma'adim [Mars] has [יש לו] a resembling sphere [וגלגל הדומה] ... [?] ... [it resembles] in all its quarters the resembling sphere of [בכל פאתיו לגלגל הדומה של], as I have written; and its eccentric sphere [וגלגלו יוצא]

in all its quarters, like the eccentric sphere of [בכל פאתיו כגלגל יוצא של], as I have written, its degree [מעלתו], as the measure [כשיעור] ... [?] ... its motion, which is [?] parts each day [תנועתו שהם בכל יום ל?] [חלקים], and 27 [?] years [?] [וכ"ז שנות]

its epicycle sphere [גלגל הקפתו] in all its quarters, and like that of [בכל פאתיו וכשל], as I have written, its degree [מעלתו] ... [?] ... as the measure of its motion, which is 28 [?] parts each day [כשיעור תנועתו שהיא כ"ח [ח]לקים בכל] [?] [יום]

The resembling [sphere] [הדומה] — it has a resembling sphere [יש לו גלגל הדומה], in all its quarters like the sphere of degrees [בכל פאתיו] [וכגלגל המעלות], and the measure of its motion is [?] thirds each day [וכשיעור תנועתו] [שלושיות בכל יום]

f. 29r

Li-L3.

And it seems to me [?] [ולנע"ד] that this is as the measure for all the spheres prior to the sphere of degrees [גלגל המעלות] [הגלגלים הקודמים לגלגל המעלות], and its eccentric sphere in all its quarters [בכל פאתיו] [והגלגל יוצא בכל פאתיו]

like the sphere of degrees [גלגל המעלות] ... [?] ... in the measure of its motion [וכשיעור תנועתו]; and there is disagreement on this [ויש בזה מחלוקות] [?]

[?] ... in one year, which is 365 days and a quarter [שהיא שס"ה ימים] [?] [ויאין לה] [?] [ורביע]

L4-L7. (A new body opens at L4 after a mid-line ".)

epicycle sphere [גלגל ההקפה] " Nogah [Venus] has a resembling sphere [נוגה יש לו גלגל הדומה] in all its quarters, like the cavity of the sphere [?] of Shabtai [Saturn] [של שבתאי] [כחלל הגלגל]; and its second [?] sphere is called [והגלגל ה'בג' נק']

the eccentric sphere, in all its quarters like the eccentric sphere of Shabtai [כגלגל יוצא של שבתאי], except [זולתי] in the measure of its motion, which is 59 [?] parts [שהיא נ"ט?] [חלקים]

[?] ... like the motion of the eccentric sphere of Chamah [the Sun] [כתנועת גלגל יוצא של חמה]; and its epicycle sphere in all its quarters like that of Shabtai [וגלגל הקפתו בכל פאתיו כשל שבתאי], except [?] in the measure

of its motion, which is each day 37 [?] parts [חלקים] [ל"ו] and [?]; and some say [י"א] that it has three epicycle spheres [כי יש לו ג' גלגלי ההקפה]

¹⁰ Kochav [Mercury] has

L8-LI4.

a resembling sphere in all its quarters, like the cavity of the resembling sphere of Shabtai [לו גלגל הדומה בכל פאתיו כחלל הגלגל הדומה של שבתאי]; and its second [?] sphere is called the touching [?] [ה[נוג]ע/ה] נק' [ה[ב]ג'] ... [?] ... eccentric, and the order [יוצא וסדר]

Its motion is contrary [תנועתו הפכיית], and it is continuous toward the west [ושיעור תנועתו]; and the measure of its motion is 29 [?] parts [כ"ט? חלקים], divided [מתחלקי?] in every

day, as the measure of the motion of the eccentric sphere of Chamah [the Sun] [יום כשיעור תנועת גלגל יוצא של חמה]; and its third [?] small sphere [וגלגלו הג/ב] lies between the two parts of the thickness of its touching sphere [בין ב' חלקי' עובי גלגלו הנוגע]

and likewise its eccentric sphere, its carrier sphere, its touching sphere and its resembling sphere [וכן לגלגל היוצא והנושא והנוגע והדומה], in all their quarters, to the eccentric sphere of Shabtai [בכל פאתיו לגלגל היוצא של שבתאי], except [זולתי] in the measure

of its motion, which is each day one degree and 51 [?] parts [שהיא בכל יום], divided [מתחלקי]; its resembling sphere, and the fourth [?] sphere, is called the small sphere [גלגל הקטן]

of the epicycle, in all its quarters resembling the epicycle sphere of Shabtai [של ההקפה בכל פאתיו הדומה לגלגל הקפת שבתאי], except [זולתי] in the measure of its motion, which is each day 3 [?]

degrees and 50 [?] parts and 24 [?] seconds [שניות [ד?]] ונ' חלקים וכ"ד?];
 and some say [?] [וי"א] that it has three epicycle spheres [גלגלי ההקפה]
 " Levanah [the Moon] — it has already been set out above [לעיל [בארה?]]
 apart from

LI5-L22.

as I have written [כמ"ש], that its resembling sphere is called the sphere of the "straight serpent" [כי גלגל הדומה שלה נק' גלגל נחש בריח] ... [?] ... resembling the sphere of degrees in all its quarters [הדומה לגלגל המעלות בכל פאתיו], except [?]

in its motion, for it moves in the contrary sense [תנועתו כי מתנועע להפך], and it is [?] of the continuous [והוא מן המתמדת] ... [?] ... toward the west [למערב]; and the measure of its motion is 3 parts each day [ושיעור תנועתו בכל יום ג' חלקים]

and 11 [?] years approximately [וי"א שנות בקירוב] ... [?] ... it completes [?] one full revolution [סיבוב שלם פעם א'] in 28 [?] years and [?] months and 17 [?] days [כ"ח שנה ו'א/ח' ח'ד/ל'שים וי"ז יום]

and a half [וחצי] [?] 28 [?] years and 20 [?] days [כ"ח? שנה וכו' יום]; and this motion is called the mean motion [מהלך נק' מהלך התניכון] [?]; its second sphere is called the touching sphere [גלגל שני שלה נק' גלגל הנוגע]

[?] ... eccentric, since its poles and its equinoctial line [כי קוטביו וקו השווה] are called [?] ... [?] ... of it, and they incline [?] [שלו והם נון?] from that of the sphere of degrees [?] to each [?]

its centre lies outside [?] [מרכזו יוצא] ... [?] ... of degrees; and likewise [?] the order of its motion [סדר תנועתו] ... [?] ... like the motion of its inner [?] sphere [מתמדת למערב], continuous toward the west [שלה] [כתנועת גלגל התוך?]

and the measure of its motion is each day 1[?] degrees and 50 [?] parts [שיעור] [חלקים מתחלקי?]; ... [?] ... parts, divided [חלקים מתחלקי?]; the sphere of degrees, and it shifts a revolution [גלגל המעלות ומעתיק סיבוב]

L22–L28.

[?] of it, in 8[?] days [כפ"ן?] [ימים] and [?] years and so many parts [גלגל ג' שלה נק' גלגל היוצא הנושא הנוגע]; its third sphere is called the eccentric, the carrier, the touching [גלגל ג' שלה נק' גלגל היוצא הנושא הנוגע]

[?] ... that 52 [?] parts are the thickness of its touching sphere already named [?] ... [כי נ"ב?] חלקי עובי גלגלה הנוגע הנו' [ובכל פאתיו?] לגלגל היוצא של שבתאי]

except [זולתי] in the measure of its motion, which is each day 24 [?] degrees and 22 [?] parts approximately [שהוא בכל יום כ"ד?] מעלות וכ"ב?] חלקים בקירוב], divided; its sphere

the motion of the epicycle sphere, which resembles the sphere of the "straight serpent" [תנועת גלגל ההקפה הדומה אל גלגל נחש בריח] in every quarter of it [בכל?]; and the order of its motion is continuous toward the west [וסדר תנועתו מתמדת למערב]

like it [כמוהו], except [זולתי] in the measure of its motion, which is each day 13 [?] degrees and 30 [?] parts approximately [בכל יום י"ג?] מעלות ול?] חלקים [מתנועתו] — of its own motion [בקירוב]

itself [עצמו]; and such is the matter [וכזה הוא הענין] [?] for all the rest of the epicycle spheres [לשאר גלגלי ההקפה], which have two [?] seconds [שהן יש להם ב' שניות]

their motion follows the order of the diurnal sphere [תנועתם כסדר גלגלן] [היומי] for each [?]; it has no inclination [אין לו נטייה] [?] other than the inclination of its sphere [זולתי נטיית גלגלה]

f. 29v

L1–L9.

the eccentric, the touching [היוצא הנוגע]; and also, since its motion is contrary [וגם כי תנועתה הפכיית] to [?] the motion of its eccentric sphere [כי זו תנועתו] [למערב], for this one moves westward [?] [מתנועת גלגלה היוצא]

continuous toward the west [מתמדת למערב], and [?] in part of their revolution [בקצת הקפתם] [?]. Shabtai [Saturn] encompasses its sphere in every [?] year [מ"ד?] [יום] [שבתי מקיף בגלגלו בכל?] שנה [?] [44]

Tzedek [Jupiter] in 12 [?] years [צדק כ"ב שנים], and also less [?] days [בין?] [ח] חדש] in 18 [?] months [מאדים?] [גם פחות ל?] יום] and also 22 [?] years less 3[?] days [גם כ"ב?] שנים פחות ל"ח?] יום]

Chamah [the Sun] in 365 days and a quarter [יום כשס"ה יום ורביע]; Nogah [Venus] in 11 [?] months [כ"א/ב חודשים] ... Kochav [Mercury] in [?] months [כ"ב חודשים], which is 24 [?] days [יום] for each

[?] Levanah [the Moon] in a month [?] [לבנה כחדש], which is 29 [?] days and 12 [?] hours [יום וי"ב שעות] and 7 [?] parts [ותשנ"ג חלקים], which is 2 [?] days and a half [שהוא ב' ימים ומחצה]

[?] ... above and below [מעלה ולמטה]; and the size of the stars themselves [ושיעור הככבים עצמם]: Shabtai is larger than the globe of the earth by 80 [?] parts [שבתי גדול מכדור הארץ פ' 80 חלקים]

Tzedek [?] parts [צדק] of them two parts and a half [ב' חלקים וחצי]; Chamah [?] 10 [?] parts [ק"ן חלקים], and also 1 [?] [גם ק"א חלקים]; Nogah is smaller than the globe

of the earth 13 [?] times and [?] parts [ל"ג חלקים]; Levanah is smaller than the globe of the earth [?] 30 [?] parts [ל' חלקים]; Kochav is smaller than the globe of the earth

[?] parts, and also 3 [?] parts [מ' חלקים גם ל"ט חלקים]

[ד'] פרק י

L10–L21.

Chapter 14 [?] — on the exposition of the course of the [?] [כביאור מהלך ה'] ... [?] ... to know [?] and the course of the [?] [לדעת ומהלך ה'], and the rest of the courses already named [ושאר המהלכים הנז']

[?] ... in one manner [?] [כאופן אחד] ... [?] ... the courses [המהלכים] and the variations in them [והשינויים שבהם], which [?] are in each and every star [אשר בכל ככב וככב] ... [?] ... and also the variation of the courses [גם שנוי המהלכים] [?]

the course of this star as against its fellow [מהלך הככב הזה אל חבריו] 'and the point is this [והענין]: for behold, had [?] all the spheres [כי הנה אילו כל הגלגלים] had one order of motion [היתה סדר תנועתם]

alike [שוה] — in the sense that they all revolved continuously westward [כענין] or to the contrary [אל היפך] — and were they also equal in the measure

of their motion [כשיעור תנועתם], in the sense that they all moved an equal measure [כענין שכלם יתנענעו שיעור שוה] each day, and the reckoning [?] of their revolution were equal [ותהיה מציאת סיבובם שוה]

and also that they all revolved about one [?] centre alike [גם שיהיו כלם סובבים] — [על מרכז אחד] שוה [היו] all the spheres would be equal, of one course alike [כל הגלגלים שוים כמהלך א' שוה]

for them all [לכלם], and [?] ... [?] ... the courses of them all [מהלכי כלם] . But now, since they have come to differ [אמנם עתה אשר נשתנו]

this [?] in all the variations [בכל השינויים] which are [?] in the order of their motion [כסדר תנועתם], and not [?] in the measure of their motion [ואם] — and if [ולא?] כשיעור תנועתם]

in the knowledge of their courses [בידיעת מהלכם] it is hidden [נעלמת] [?], since there is no sphere whose course resembles its fellow's [כי אין מהלך גלגל א'] [הדומה לחבירו]; and therefore [ולזה] [?] to know the course of [?]

[?] the sphere [?] [גלגל ה] [?], for this variation [כי שינוי זה] [?] this difference falls [ה[ת]חלפות הוזה נופל] [?] ... [?] ... in the whole assembly of the spheres [ב[כללות הגלגלים] [?] together [?], and also in every star

and star [בכל ככב וככב] [?] ... [?] ... and the variation of the courses [ושינוי מהלכים]; for it has already been set out in the previous chapter [כי כבר נתבאר] [בפ' שעבר] that there is a star comprising three [?]

L22–L28.

spheres differing in all the variations already named [גלגלים מתחלפים בכל] [?] [ויש ככב בעל ג' גלגלים]; and there is a star possessed of three spheres [והפחות שבכלם] [?]

— which is Shemesh [the Sun] [שהוא השמש] [?] — has two spheres [יש לו ב' גלגלים], differing [משתנים] [?] ... [?] ... and differing in their conditions [וזהוה[ח]ק שינוי א] [?] [is the rule of one variation] [?]

comprising several variations [כולל כמה שינויים]; and there is yet one further variation [עוד יש שינוי אחד] [?] ... in one manner [כאופן אחד], and it is the matter of the inclination of the inclining spheres [והוא ענין נטיית הגלגלים הנוטים]

one from another [זה מזה], for perhaps [?] they differ [כי אולי שינוי] [?] in the order of their motion [כסדר תנועתם] [?] ... [?] ... and in the measure of their motion and their course [וכשיעור תנועתם ומהלכם]; now [?] there is a variation

between them [ביניהם], in the matter of the latitude that lies between them [כענין הרוחב אשר ביניהם], for [?] ... [?] ... the inclination of the sphere carries the star [?] [נטיית הגלגל יותר הככב] [?] to the south, or [לדרום או]

to the north [לצפון], like the rest of the stars [כענין שאר הככבים], or in the matter of the equinoctial line [ואו כענין קו השווה] [?] ... and the equinoctial [והשוה] [?] [של חצות המעלות] [?] of the halving of the degrees [?] [ולפי כך] [?] and accordingly [?]

we [אנו]; and we shall begin [?] to reckon the course of each and every sphere [ונתחיל לחשוב מהלך כל גלגל וגלגל] [?] ... [?] above and below [ולמטה] [?] we shall see [נראה] whether [אם] they have courses

f. 30r

L1–L8. (The side opens with the word f. 29v's catchword predicted — see the seam note below — and runs on in the comparison of the bodies' motions.)

equal [שווים] in [?] their motion toward one side, reckoned together, and not [ב[?] תנועתם לצד א' נחשב יחד ולא] [?] [ויש בהם מתחלפים כ[ס?]דר] [?] according to the order [?]

their motion [תנועתם], since this one revolves toward this side while that one turns it the opposite way [כיון שזה סובב לצד זה וזה מסבבו להפך] [?] the lesser motion [ל[?]ות המהלך הפחות]

the motion of the [?] [מהלך ה] [?] ... [?] ... the motions of the spheres in each and every star [מהלכי הגלגלים שבככב וככב]

[?] ... and we shall know [ונדע] ... [?] ... the motion of all the stars [שנחבר [?] המחלקים] ... [?] ... that we may join [?] the parts [מהלך כל הככבים] [?]

of the sphere of this star against the motion of its fellow [של גלגל הככב הזה], and we shall know [ונדע] ... [?] ... whether they are equal or not [למהלך חברו] ... [?] ... [הם שוים או לאו]

and consider [?] the matter of the interval between the one and the other [והת[ב/כ]ונן בענין המרחב שבין זה לזה] ... [?] ... the two stars will not stand at one equal degree [?] [לא יהיו שני הככבים במעל[ה] א' שוה] [?] ... [ונקח]

also the inclination of the spheres, as has been mentioned [גם נטיית הגלגלים כנו']; and here we find [?] that their motion [והנה נמצא שתנועתם] ... [?] ... the difference of the motions [שינוי המהלכים] ... [?] ... the difference [השינוי]

which follows always [הנמשך תמיד] from the order of the motion, or the measure of the inclination [מסדר התנועה או שיעור הנטייה] [?] ... [?] ... a matter [ענין מבורר] set out [already]

L9–L21. (From L15 the lines shorten sharply: two drawings are set into the left half of the writing block and the prose runs only in the right half beside them. That is layout, not damage — the drawings occupy exactly the space the short lines vacate.)

for every difference that follows always [לכל השינוי הנמשך] from the cause of the going-out of the centre [מסיבת יציאת המרכז] ... [?] ... and we shall set out the matter [ונתאר ענין]

the difference that arises from the eccentric sphere of Shemesh [the Sun] [השינוי שיש מן הגלגל היוצא מרכז של השמש] ... [?] ... to the sphere of degrees [מרכזם שוים] [?] ... [?] ... their centres equal [אל גלגל המעלות]

and from this you may infer for all the rest [ומזה תקיש לכל השאר], and so from the rest of the stars [כן משאר הככבים] ... [?] ... to the sphere of degrees [אל גלגל המעלות], as the quarters [?] of the spheres [כפ[א]תי הגלגלים], which in all [שבכל]

star [ככב] ... [?] ... from the [?] sphere of Shemesh [מן הגלגל ה[?] של השמש] [?] ... [?] ... to the eccentric sphere [אל גלגל היוצא] · already, earlier [כבר קודם] [?]

for the centre of the eccentric does not [incline?] to any side [כי מרכז היוצא] ... [?] ... [אינו נו[ט/ג]ה לשום צד]; as to their motion, it is aligned on the equinoctial line of the [sphere of] degrees [לתנועתם הוא מכון בקו השוה של המעלות], and when [וכאשר]

[?] ... the two spheres lie one within the other [ב' הגלגלים זה בתוך זה], and [?] their centres [מרכזותם] are equal [שוים] · and behold, the body [והנה ככב]

of Shemesh is fixed on the equinoctial line of the inner sphere [השמש קבוע] [בקו השוה של גלגל הפנימי]

and the twelve constellations [?] and stars [וי"ב מ[ז/ע]לות וכוכבים], as the equinoctial line of the sphere [כקו השוה גלגל]

of the outer degrees [המעלות החיצון]; and the body of Shemesh [וככב השמש] ... [?]

[?] ... the middle line, which is at the centre [קו האמצעי שבאמצע]

the breadth of the degrees, and the sphere of degrees [רוחב המעלות וגלגל המעלות] because of the great slowness of its motion [לרוב איחור מהלכו], that which moves [המתנועע] is [?]

[? ... the motion [התנועה], and it is not called "moving" [ואינו נק' מתנועעת]

L22–L28. (L22 is short — the gold wheel still occupies the left half of the writing block at that height; from L23 down the lines run full width again. The side ends at L28, with the catchword beneath and roughly the lower 45% of the leaf blank.)

[?] ... as we explained [כמו שביארנו] ... [?] ... for the principle is fixed [כי עיקר קבוע]

twelve [?] degrees — it is the diurnal sphere [י"ב [?] מעלות הוא הגלגל היומי], and by them we [?] ... [?] ... for this is like a sphere [?] [כי זה הוא כמו גלגל]

the [sphere of] degrees is fixed and enduring, and does not move at all [המעלות קבוע וקיים ואינו מתנועע כלל]; and the body of Shemesh, being embedded in the sphere [וככב השמש כהיותו תקוע בגלגל]

the eccentric [היוצא] turns about, and the star lies within the equinoctial line of the [sphere of] degrees [מתגלגל והכוכב תוך קו השווה של המעלות]; and it began [מנק[ודת] ראש טלה] from the point of the head of Aries [?]

and [?] 365 days and a quarter [שס"ה ימים ורביע], until it came back [עד שחזר] ... [?] ... to the point of the head of Aries as at the outset [לנק' ראש טלה כבתחילה] and we have already explained [וכבר ביארנו]

[?] ... that every sphere, small and great, is divided [כי כל גלגל קטן וגדול] into 4 [?] quarters [לד/ר' רביעים] — see QA; pass 1 committed 7, the second witness withholds it] and 12 parts [וי"ב חלקים] and 360 [?] degrees [ושס"ם מעלות] — see QA; the second witness settles this as ש"ס = 360 on a leaf-local ם/ס discriminator], and these are subdivided [ונחלקים]

and into seconds and thirds and so on [ושניות ושלשיות וכו'], throughout the division of the said sphere of degrees [בכל התחלקות גלגל המעלות הנז'] [?] [?]. And now, according to the sphere of Shemesh [והנה לפי גלגל השמש]

Diagram. A wheel drawn wholly in gold, set into the lower left of the writing block. No red and no blue anywhere in this drawing. Stroke by stroke, as drawn: an outer circle; a second, smaller circle concentric with it, at roughly two-thirds its radius; a vertical diameter running from the top of the outer circle through the common centre to its foot; and a horizontal diameter running the full width of the outer circle through the same centre. Five small gold ring-nodes are drawn on those lines — one at the centre, and one at each of the four points where a diameter crosses the inner circle (top, foot, left, right). The diameters run on past the inner circle to the outer circle, but no node is drawn where they meet it. There is no shading, no hatching and no arrowhead. The labels are in black ink in the body hand, at roughly half the body size; several are set radially and must be read turned.

Labels read:

- (none of this plate's labels is settled — see the census below)

Labels not read, by position, with sort-counts:

- above the outer circle, horizontal, centred over the vertical diameter: 6 sorts — a closed round first sort, then ך, then two broad sorts, then ך, then a closed final sort. Impressions סוככים and הכוכבים each fit part of the run and neither fits all of it. Not read.
- inside, upper right quadrant, beside the top node: 3 sorts, impression מחצ. Not read.
- inside, on the horizontal beside the left node: 3 sorts, impression מחצ. Not read.
- inside, immediately right of the centre node, above the horizontal: 4 sorts, impression ראשי or ראש ט'. Not read.
- inside, immediately right of the centre node, below the horizontal: 3 sorts, impression מחצ. Not read.
- inside, beside the foot node: 3 sorts, impression מחצ. Not read.
- lower left, set radially along the inner circle: two tokens, of 4 and 3 sorts, impressions מחצי and מחצ. Not read.
- lower left, set radially along the outer circle: two tokens, both 3 sorts, impression מחצ each. Not read.
- outside the outer circle at the far left, set vertically: 2 sorts, impression זה. Not read.
- outside the inner circle at the right, on the horizontal, set vertically and joined to the figure by a short black leader rule: 4 or 5 sorts, impression מכון. Not read. (This is the black rule and vertical word noted at L19 above.)

Diagram. A small figure standing to the left of the gold wheel, with clear blank paper between them — a second, separate drawing, not part of the first. Colours actually present: red-orange and blue only; no gold. Stroke by stroke, as drawn: an outer circle in red-orange; inside it a smaller circle in blue — and the blue circle is not concentric with the red, standing about 55 units to the left and 30 up of the red centre, so that the two rings run close together on the left and wide apart on the right. Within the blue circle, two solid blue dots side by side on a horizontal. As drawn, the left dot falls at the centre of the blue circle and the right dot falls at the centre of the red circle — that is a measurement taken off the leaf, not an interpretation. There are no diameters, no radii, no nodes and no labels of any kind on this drawing.

f. 30v

L1–L9. (From L4 the lines shorten: the plate on this side is set into the left of the writing block from about that height, so the prose runs in a narrowing measure to its right. Layout, not damage.)

It did not go out from among them [היה יוצא מתוכם] לא [recte: אם] — △ the opening word is לא, not אם: opposite sense. Settled on the ink at both the f. 30r catchword and here; see QA. Scope: the FIRST WORD only — the rest of the clause was not re-read and is not endorsed by that ruling], it would be

[?] of its sphere [היה מקן?רת גלגלו]; and it is set within the [?] of the sphere of degrees, and the [?] [ונתון בתוך מקן?רת גלגל המעלות ומקן?רת] [?]

of the other, within the [?] of the last [האחר תוך מקן?רת האחרון]; and all the degrees of this one and its parts are set opposite this one and its parts, equally throughout [וכל מעלות זה וחלקיו מכוונים כנגד זה וחלקיו בשוה בכל]

the parts of the sphere, as I have drawn it for you in this [?] figure [חלקי] [האמת עתה] the truth. Now [האמת עתה]

that the sphere of Shemesh is eccentric [שגלגל השמש הוא יוצא מרכז]; and we find that in every [?] [נמצא כי בכל] [?]

its centre [הקטן/צפון הוא] [?] ... the one is the greater of the two [מרכז] [?]

other; for on the [small/northern] side, the greater part of the eccentric sphere lies within [האחר כי לצד ה[קטן/צפון] רוב גלגל היוצא נתון תוך]

the cavity of the sphere of degrees, while on the side the reverse holds [חלל] [גלגל המעלות ולצד ד/ה/רום הוא להיפך]

for the lesser part of the eccentric sphere lies within the cavity of the sphere [כי מיעוט גלגל היוצא נתון תוך חלל גלגל]

of degrees, in this manner [המעלות כזה] · ... [?] ... you will see that, as the measure [תראה כי כשיעור]

L9–L22. (L9–L14 are short lines — the plate occupies the left of the writing block down to about the middle of the side; from L15 the measure opens out to full width again.)

of degrees, in this manner [המעלות כזה] · And you shall also know [?] that, as the measure [גם תדע/עק] [כי כשיעור]

[?] ... so grows the [?] of the eccentric sphere [כן /יגדל מקן?רת גלגל היוצא]

[?] ... small, upon the southern [?] [קטן על מקן?רת הדרומי] [?] twice the measure [כפלים מהשיעור]

[?] ... a measure of [?] to the degree in its sphere [שיעור] [למעלה בגלגלו] [?]

and a measure [שיעור] [?] of the eccentric sphere [גלגל היוצא] [?] ... of the eccentric sphere [למעלה] [?] to the degree [?]

and we find that when [ונמצא כי בהיות] [?] of the small [?] of the eccentric sphere, which is in the place of [?] [כמקן?רת קטן גלגל היוצא שהוא במקום]

if the circumference be found in its sphere — by way of example [?], 30 [?] degrees [אם היקף נמצא בגלגלו ע"ד?] [משל ל' מעלות] [?] out of the degrees of that sphere, when it has shifted [ממעלות הגלגל ההוא כאשר נעתק]

them toward the degrees, the small [?] of the sphere of degrees [אותם אל] [?] ... those opposite it are not [numeral: ?] degrees, and the sphere is divided [שכנגדו אינם] [ק] [כב] [ה מעלות מתחלק גלגל] [?] ... [המעלות מקן?רת קטן גלגל המעלות] — a three-sort numeral group with gershayim before its last sort, standing immediately before the unit-noun [מעלות]; the value is NOT read. This pass's "כך / kol kach ("so much") is refuted on the final sort. Δ Sort 1's binding to the group is firmer at L20 than here — at L16 the flanking gaps do not separate; this pass's own unread [?] immediately before its כך is this same sort. See QA]

of degrees; and therefore Shemesh will be distant [המעלות ולכן ירחק השמש] ... [?] ... it is from the distance [הוא מהמרחק] ... [?] ... the motion, since it is [?] a great measure [התנועה לפי שהוא [?] שיעור גדול]

in the parts of its sphere; and according to the part [בחלקי גלגלו וכפי חלק] ... [?] ... and it [?] ... the parts of the sphere of degrees [חלקי גלגל המעלות] ... [?] ... it goes, and [?] a small measure, and it falls behind, as its motion [שיעור מועט] ומ[?] ונתאחר כמהלכו]

and when Shemesh revolves in the [?] of the south of its sphere [וכהיות השמש] ... [?] ... for it is the reverse: it grows distant, or [?] [?] הוא להפך כי [?] ירחק או]

the motion — by way of example [התנועה ע"ד משל], if [?] [numeral: ?] degrees [ממעלות גלגלו הנה [?] ל'] 30 [?] degrees [ממעלות] — the same three-sort numeral group as at L16, sort for sort; value NOT read. כ"ך / kol kach refuted on the final sort. Sort 1's membership in the group is firm here — the gap to the preceding word is wider than the gap between sort 1 and sort 2. See QA] ... [?] ... degrees out of the degrees of its sphere; here, then, [?] 30 [?] degrees [ממעלות]

out of the parts of the sphere of degrees [מחלקי גלגל המעלות] · And we find that sometimes it grows distant [ונמצא כי לפעמים ירחק] ... [?] ... the motion of the eccentric sphere is diminished in it, at its completing [יפחות מהלך גלגל היוצא] [?] בו בשלמו]

against the sphere of degrees, and it is as when it stands in the [כנגד גלגל] [המעלות והוא כהיותו ב]קטן/צפון [?] of the south [ולפעמים יוסיף כשהוא במק[?]רת הדרום] · [וכמו]

L23–L28. (The side ends at L28, with the catchword beneath and roughly the lower half of the leaf blank.)

which we drew above: that we drew out a straight line from the centre [שציינו לעיל שהוצאנו קו ישר מהמרכז] ... [?] ... of the degrees, and it runs on evenly [עת השמש] ... [?] ... at the time Shemesh [המעלות ותמשך בשוה]

and from there it runs on further, evenly, to the end of the degree[s] [ומשם] ... [?] ... and it arrived; and at the point where it came up we marked a letter upon it [והגיע ובנקו' כאשר עלה ורשמנו עליו אות]

[?] ... and we go back to draw out another straight line from the centre of the sphere [ונחזור להוציא קו ישר מהמרכז גלגל] ... [?] ... at the time [עת] [היוצא והמשך כנגדו בישר]

of Shemesh; and from there the straight line runs on further to the end [השמש] ... [?] ... the part of the degrees, and it arrived; and the point [אל אחת [?] ממנו] distant from it [חלק המעלות והגיע ונקו']

when it came up, and we marked upon it [כאשר עלה ורשמנו עליו] ... [?] ... there is between them [יש ביניהם] ... [?] ... in this [בזאת] ... [?]

that these [?] spheres have a single centre [ש[?] הגלגלים מרכזו א' להם]: so that when you draw out a straight line from the centre of both of them, and we extend it [אשר כשתוציא קו ישר מן המרכז של שניהם ותמשיכנו]

Diagram. A large wheel set into the left of the writing block. Colours actually present on this plate: gold and blue. There is no red anywhere on it. Stroke by stroke, as drawn: a large gold outer circle; inside it a blue circle, drawn in a broad opaque blue and clearly not concentric — the two rings run close together on the upper right and stand well apart on the lower left. Across the whole figure runs a horizontal gold line, extending a short stub past the gold circle on the left; a vertical gold line runs from the top of the gold circle to its foot. Four small gold ring-nodes are drawn on the blue circle, where these two lines cross it: at its top, its foot, its left and its right. Besides the two straight axes there are at least three further slanting gold lines, forming a fan whose lines converge on the ring-node at the foot of the blue circle and run out to the gold rim — one up to the upper right, and two down to the lower rim. No shading, no hatching, no arrowhead. The labels are black, in the body hand at roughly half size; most are set radially and must be read turned.

Labels read:

- upper left, set radially along the gold circle: גלגל המעלות — the sphere of degrees. Two tokens, גלגל + המעלות, both separating cleanly.
- upper left, set radially just inside the blue circle: גלגל היוצא — the eccentric sphere. גלגל separates cleanly; the second token reads יוצא with or without the article, which I cannot settle.
- immediately below the ring-node at the top of the blue circle, set horizontally: שמש — Shemesh [the Sun]. Three sorts, all separating; whether the article ה precedes is not resolvable.

Labels not read, by position, with sort-counts:

- above the gold circle, horizontal, centred: two tokens, of 4 and 3 sorts. Impressions מזרח ("east") and טלה / עלה. Not read — see the QA note on the cardinal pair below.
- below the gold circle, horizontal, centred: two tokens, of 4 and about 6 sorts. Impression of the first is מערב ("west"); the second I cannot even count with confidence. Not read.
- inside the gold rim, upper right: two isolated single sorts with a clear space between them. First: ה, ת or א. Second: ב or כ. Construction letters — not read.
- inside the gold rim, lower centre-right: two isolated single sorts, again spaced. First: ל or א. Second: ב or כ. Construction letters — not read.
- at the ring-node at the foot of the blue circle: 3 or 4 sorts, impression מחצ / מרכז. Not read.
- inside, lower left, set radially: two tokens, the first of 3 sorts with the impression שפל (the glossary's nadir/perigee). Not read.
- inside, lower centre, set radially: two tokens, impression מרכז + one further token. Not read.
- inside, lower right, set radially near the blue circle's right node: two or three tokens; one gives an impression of מחצית. Not read.

- outside the gold circle at the far left, set vertically: two tokens, of 3 and 4 sorts. Not read.

f. 31r

L1–L8.

[?] with Shemesh [the Sun], and it will yield for us, up to the halving [?] of the degrees [המעלות] [?] [ח/ק] צות [?] עד [?] עם השמש ותוצא לנו [?] [ד/ר] ק [?] and there will not be there more than one line alone, and not two lines [לא יהיה שם רק קו א' לבד ולא ב' קוים]

parts [חלקים] [?] [?] and it has already been set out [וכבר נת'] that the principle [כי עיקר] [?] [?] the stars [הככבים] [?] was posited according to their meeting [הונח כפי פגישתם]

[?] star [ככב] against the sphere of degrees [המעלות], according to the [ל] המעלה המכוונת כנגדו [?] to it, the degree aligned opposite it [ולכן המהלך]

by [?] the motion of Shemesh [השמש] [ל] [ש/פ] מהלך [?] the remaining seven planets [שאר ז' ככבי לכת]: in its diurnal sphere an equal motion is posited [כי מהלכו], since its motion [היומי הונח מהלך שוה]

today is as its motion [?] and as its motion tomorrow [היום כמהלכו] [א/ח] מש [?] and this is posited contrary to [?] the mean motion [וזה הונח הפך] [כי הונח מהלכו], since its motion is posited [מהלך ה] [א/ח] מצעי

by the measure of the parts of its own sphere, and not by the parts of the degrees of the sphere of degrees [לכל המהלך שליו] [כשיעור מעלות וחלקי גלגל המעלות], for the whole of its motion [לכל המהלך שליו]

[?] and their motions [?] [מתח] [?] [?] according to [?] [כפי] [?] the motion [מהלך] by the measure of the degrees and parts of the sphere of degrees [שהוא]

sometimes it falls short of [?] the motion of the star in its own sphere [לפעמים] [פוחת מ] [מהלך הככב בגלגלו עצמו] and sometimes it adds, by the motion of the parts of its own sphere [ולפעמים מוסיף כמהלך חלקי גלגלו עצמו]

L9–L21.

Now this posited one is called the true motion [הנה זה הונח נק' מהלך האמיתי], for this is the [?] [כי זהו המ] [?] to know the [?] and the judgments, as mentioned [לדעת הה] [כות והמשפטים כנז'] [והנה]

the line marked [?] above [הקו הנ] [שם למעלה] [?] beneath א' is set the true place of Shemesh [the Sun] [תחת א' הונח מקום השמש האמיתי] and beneath ב' is set its place [ותחת ב' הונח מקומו]

the true [האמיתי]. And [?] that when Shemesh, or a star [?] of the remaining seven planets [כי כהיות השמש א/לו הככב משאר ז' ככבי לכת] is at any of the places of their eccentric sphere [בכל מקומות גלגלם היוצא]

there is a difference between their mean motion and their true motion [יש] [שינוי בין מהלכם האמצעי אל מהלכם האמיתי] [?] when it stands opposite the point of the south that is in the [?] [הדרום] [הדרום] [שב] [?] — Δ at L12 the word carries FIVE sorts, ב-ו-ר-ד-ה, counted on the leaf; הרום (the apogee)

would need four and is refused here. Δ This ruling is scoped to L12 ALONE — the five other הרים on this leaf and on f. 31v are untouched and are NOT settled by it. See QA]

or opposite the point of the perigee [?] that is in the south [[?] שפל [?] א] כנגד נק' שפל [?] that is in the south [?] the two motions [ב' המהלכים], the mean and the true [האמצעי והאמיתי], are not [?] [א ... אין [?] [?] posited [הונח [?] [?]

the motions are there upon one straight line [המהלכים הם שם על קו א' ישר], and [they are] not [?] inclining [ו] [?] one from the other [זה מ] [?] than in the other places [בשאר מקומות], since [?] [כי כ] [?]

Shemesh [?] — from them [?] go out two differing lines [מחלפים ב' קוים מתחלפים], one from the centre of the [sphere of] degrees [א' ממרכז המעלות], and [one? / not?] from the centre of the eccentric sphere [ו] [א' לא] ממרכז גלגל היוצא]; and therefore [ולכן]

when Shemesh or the star stands at any of the places of its sphere [כהיות השמש] [?] [זולתי באותם ב' נק'] other than at those two points [אז הכבב בכל מקומות גלגלו] the motions [?] [כפ' התנועות] — then there is [הנה אז יש]

a difference between the mean motion and the true motion [שינוי בין מהלך] [?] remember [?] this, and with this [האמצעי למהלך האמיתי]; and already [ו] [וכבר] [?] mentioned [הנזכר] [?] above [למעלה] [?] [זכור] [?] זה ועם זה]

that we shall write in this [שנכתוב בזה] [?] and we shall set out [ונבאר] [?] by the measure of [?] [כשיעור] [?] between them [שביניהם] [?] Know that when it is [דע כי כהיותו]

Shemesh opposite [?] [השמש כנגד] [?] or [?] the point [?] [נק'] [?] apogee and perigee [?] [רם ושפל] [?] there is no difference between its [?] place and [אין הפרש בין מקומו ה] [א]

the true [האמיתי]. But from there onward [?] [אבל משם ולהלאה] sometimes it falls short and [sometimes] [לפעמים חסר ולפעמים] [?] its motion [?] greater [יותר] [?] when it is at [?] degrees [בהיותו במעלות] [?]

[?] which are southern [שהם דרומיים] [?] the true motion is less [?] [בהיותו במעלות] [?] at [?] degrees [מהלך האמיתי פחות] [?]

L22–L28.

then [?] the true motion is greater than the mean [אז המהלך האמיתי יתר] [?] [מהאמצעי]. And now, by the measure of the distance from the point of the apogee [והנה כשיעור] [הרחק מנק' הרים] [?] the difference is set at [numeral: ?] [השינוי הונח ב']

parts and [numeral: ?] seconds [חלקים ו] [שניות] [?]; and if it moves off [?] ten degrees [ו] [אם יתרחק עשר מעלות] [?] the difference will be [numeral: ?] parts and [numeral: ?] seconds [כ' חלקים ו] [שניות] [?] and it goes on adding [ועוד יוסיף]

this difference, until the difference reaches [numeral: ?] degrees and parts [?] [זה השינוי עד שיגיע השינוי אל ב' מעלות וחל] [?] of its course, as above [מהלכתו כנ"ל] [?] [שהוא שיעור] [?]

82 [פ"ב] — sort 2 is a wide C with a base sweeping left, where this hand's ג is a narrow downstroke whose foot kicks right, so פ"ג = 83 is refused on form; sort

1 is positively פ by its inward descending tongue. Δ The VALUE 82 follows from this codex's own sort-count rule (פ + a single letter is a gematria; פ + a two-letter numeral is פרק) and not from a fresh reading of the value, and it carries a live dependency on L24's line-end, which is in dispute between the two passes and was not resolved. See QA]; and this will be when Shemesh is at [?] degrees [מעלות] [?] [זוה יהיה כהיות השמש] [?] differing [מתחלפים]; and afterwards it will go on diminishing [?] [ואח"כ ילך הלוך ותחסר] the difference, according to [השינוי כפי]

the measure of the excess, as mentioned [שיעור היתרון כנז], until it reaches the first degree [?] [עד שיגיע כמעלה ה[רא]שונה] [?] from this, that its perigee [?] was [ולא ישתנו] [?] [מן זה שהיה שפל רומן] and they will not differ [?]

the two motions [ב' המהלכים]; and afterwards it returns and adds to the difference [ואח"כ חוזר ויוסיף השינוי], until Shemesh reaches [numeral: ?] degrees from the south [?] [עד שיגיע השמש ל?] [מעלות מן ד[ר?]ום]

the difference is set at [numeral: ?] degrees and a half [מעלות] [ב'?] [השינוי הונח] [?] [וזהו תכלית השינוי], and this is the utmost of the difference [?] [ואח"כ ילך הלוך ותח[ס/ז]ור] [?] [עד שיגיע לבלתי] [?] and preserved verbatim in the notes below.]

f. 3IV

Li-L8.

Sartan [Cancer] — which is the apogee of Shemesh [the Sun] [שמש] — סרטן שהוא רום השמש — the leaf's opening word, settled on its own ink: ס (closed ring with a lower-left tail) · ר · ט · ן (a bare vertical descender). מהלך is refused: there is no ל ascender anywhere in this word. Residual: sort 2 is this codex's ר/ד pair and no reading here turns on it. See QA] [?] the mean motion and the true [מהלך האמצעי והאמיתי], as mentioned [כנז]; and in this way the alternation returns [ועד"ז חוזר חלוף]

[?] And now I have shown you [והנה הראיתך] [?] that which preceded, as above [שקדמת[ה] הנ"ל], for when Shemesh is at the point of the apogee and the perigee [כי כהיות השמש בנק' הרום ושפל]

Shemesh [השמש] [?] there is no [?] difference [שינוי] [?] the two motions [ב' מהלכים] [?] and afterwards [?] there are differences [יש שינויים], and not [?] all [ולא כל] [?]

[?] and according as it moves further from the point of the apogee or the perigee [?] [כל] [?] [ית[ר]חק מנק' הרום או שפל] [?] the difference grows [יגדל השינוי], until [?] two other points [עד [?] ב' נק' אחרות]

[?] since [?] is set [כי [?] הונח] [?] the utmost magnitude of the difference [תכלית ג[ו]דל השינוי], and concerning the differences of the motions [ועל השינויים של מהלכים]

of Shemesh: they are [?] its eccentric sphere [גלגלו היוצא] [?] [השמש הם] [?] to every [?] in the remaining seven planets [בשאר ז' ככבי לכת] [?] and in truth [ובאמת]

opposite one [?] point, which is in its eccentric sphere [?] אחת נק' כנגד
[?] וכפי הנ' [?] and according to the [?] שבגלגלו היוצא

the motion of the centre of the epicycle sphere [מהלך מרכז גלגל ההקפה]; and
it moves away [?] from the [?] point [?] ותרחק מנק' הא'

[?] of the eccentric sphere [של גלגל היוצא [?]], that point was the mean
motion [הינה הנק' מהלך האמצעי]

of the star; it is posited according to [של הככב הונח כפי] [?] from the head of
[?] מראש [ט/ע/לה] [?]

the sphere of degrees [גלגל המעלות]; now that point is its true motion
[הנה הנק' מהלכו האמיתי] [?]

of Shemesh; it is posited by our reckoning the two motions [השמש הונח ע"י/ד'] [?]
[שנחשוב שני המהלכים] [?]

Diagram. A large wheel set into the left of the writing block; the prose of
L18–L28 runs on in a narrow strip to its right.

Colours actually present on this plate: gold, red-orange AND blue — all
three. That is a combination none of the three drawings on the previous leaf
shows: one there was pure gold, one red-orange and blue with no gold, one
gold and blue with no red. This codex's figures do not share a palette, and this
plate was described on its own evidence.

Stroke by stroke, as drawn. A large gold outer circle. Inside it a blue circle,
drawn in a broad opaque blue and clearly not concentric with the gold — the
two run close together at the upper left and stand well apart at the bottom
and lower right. Well inside the blue, in the upper middle, a small red-orange
circle of roughly a quarter the blue circle's diameter, drawn in a broad opaque
red-orange. A horizontal gold line runs right across the figure at about the
height of the gold circle's centre, from rim to rim. Two gold ring-nodes —
small open annuli — sit on that horizontal line, close together and both to the
left of the gold circle's centre. A third gold ring-node sits at the centre of the
red-orange circle, and a gold line runs from it straight down to the right-hand
of the two nodes on the horizontal. A second gold line descends from the
top of the gold circle to the left-hand node. A further gold line continues
below the horizontal toward the lower left. A small solid gold dot is marked
on the red-orange circle itself, at its upper left. No shading, no hatching, no
arrowhead. The labels are black, in the body hand at roughly half size; most
are set radially and must be read turned.

Labels read:

- inside the gold rim at the upper left, set radially: גלגל + a six-sort token —
the sphere of the [?]. גלגל separates cleanly; the second token does not
(see the QA note on מ/ז/ע/לות below).
- at the left, set radially below the previous: גלגל היוצא של כוכב — the ec-
centric sphere of כוכב. All four tokens separate.
- left of the red-orange circle, horizontal, beside the small gold dot marked
on it: כוכב. Four sorts, all separating.

- inside the red-orange circle, set radially: תוך — "interior". Three sorts; the first is the ת/ה class and reads ת on the detached left leg.
- below the horizontal line, right-hand node, set radially: מרכז + a six-sort token — the centre of the [?]. מרכז separates cleanly; the second token is the same מ/ז/ע/ליות problem.
- below the horizontal line, left-hand node, set radially: מרכז + a four-or-five-sort token, impression היוצא מרכז read; the second token not read.
- outside the gold circle at the lower right, horizontal: הדרומי — "the southern". Six sorts, all separating; the adjacent ד and ר are the Tier-I pair and here they differ visibly from one another on the leaf, the first squared and the second shouldered.

Labels not read, by position, with sort-counts:

- above the gold circle, horizontal, centred: one token of three sorts, impression מעלה / עלה / טלה. Not read — this is the same recurring group that stands unread at L23, L25 and L26 of the prose on this side.
- inside the gold rim, upper right, set radially: two separate runs, the first of two tokens (about 4 and 5 sorts), the second of two tokens (about 4 and 4 sorts). Both open with an impression of גלגל. Not read. No counterpart to הדרומי — no הצפוני — was found anywhere on the plate.

f. 32r

L1–L8.

[?] of its own, and the motion of its diurnal sphere; and you will understand [?] more [?] below [?] [הה[?]ה שלו ומהלך גלגלו היומי ותבין שעת[ה/ם] יותר] [?] we wrote [כתבנו], and to know the motion [ולדעת המהלך]

the true [motion] of the seven stars we named [האמיתי של ז' הככבים שאמרנו] — every one that has an epicycle sphere [כל שיש להם גלגל הקפה] — is posited by the joining of their [?] motion [היונה ע"י חיבור מהלכם הא]

of its diurnal sphere together with the motion of its epicycle sphere, which is called [ב/כ לשון] [?] in the expression [של גלגל[ה/ו] היומי עם מהלך גלגל הקפתו הנק'] [?] [?], and how much more [וכמה יותר], as [?] wrote [כמ"ש כת] [?]

ט [?] — Chapter 15[?]¹⁵

on the correction of the true motion of Shemesh [the Sun] and the remaining stars [ב/כ תיקון מהלך האמיתי של השמש ושאר הככבים] [?] for this is the correction [ולא ואז?] [כי זה התיקון]

Shemesh [?] [ב/כ לשון מנת מעל] [?] in the expression [?] [הנה ע/ד/ק] [?] [שנבאר] [?] that we set out for you [שנבארנו לך] [?] that we will set out [לך כמה] [?] שיש במהלכים [?] to you how many [?] there are in the motions [?] which is called [הנק'] [?] is posited: the motion [?] before us [מהלך האמצעי] [?] the mean motion [הרום] [?] the zenith [הונוח מהלך הנוכח לנו]

¹⁵ ט"ו = 15 — second witness, refusing ט"ז on a measured head-bar test; see QA

the third: the motion of the epicycle of Shemesh [the Sun] [הג' מהלך מעגול השמש]
 · the [[fourth]]: the equation of the [[epicycle/anomaly]] [ה'ד' מנת מ' עגול/סלול]
 the fifth: the true motion [הה' מהלך האמיתי], and this [[in particular?]]
 [ה'א/ו' מהלך]: the motion [ה'ז' ב' יחוד]

[?] before us [הנוכח] [?] [?] its meaning; for I have already informed you, as in chapter [14?] [ד' כפר הודעתך כפי"ד], that every single sphere [שכל גלגל וגלגל]

' slots stand where the ink does. 2× crops requested at (2450,1720)–(3900,1830) and ** (1050,1850)–(2600,1960) **.]

L9–L21.

there, that the upper sphere of Shemesh [the Sun] is called the sphere of degrees [הגלגל העליון של השמש נק' גלגל המעלות] divided upon the sphere of degrees into twelve parts [מתחלק על גלגל המעלות ל"ב חלקים], called [הנק' [?]] [?]; by way of example, when they are twelve degrees [כדרך משל כשהם י"ב מעלות], and each part into thirds [ובכל חלק לנשלשיות]

degrees, and each degree into [sixty?] parts, and each part into [sixty?] thirds [מעלות ובכל מעלה ל[ס/פ] חלקים]; and so [?] I have informed you [וכן [?] הודעתך]

[?] for it is posited [?] [כי הונח [?]] to the sphere of degrees [לגלגל המעלות] [?] I have informed you [?] [הודעתך כפי"ב/ב/כתי"ב] that in the sphere of [?] there are two points [כי יש בגלגל ה[?] ב' נק']. The first is the point [?] [של הגלגל ההקפה], and the point

is called the apogee of Shemesh [נק' רום השמש], and the second [?] opposite it [?] [והב' [?] כנגדו] of the epicycle sphere [של הגלגל ההקפה], and is called [?] [ונק' [שפל?] רום השמש]

is called the apogee that is in the sphere of [?] [נק' רום שבגלגל ה[?]], and is called the point opposite Shemesh [נק' נוכח השמש]; and therefore the motion of the sphere of [?] is called [?] [ולכן מהלך גלגל ה[?] נק'] the motion of the opposite point [מהלך הנוכח]

for it is the [mean?] point in the sphere of [?] [בגלגל [?]] [?] the motion of the sphere of [?] [תנועת מהלך גלגל ה[?]] — [והנה התחלת]

the reckoning of its [?] motion [חשבון המהלך ה[?] שלי] [?] always, from the moment it stood beneath the point of [?] [תמיד מן הרגע שהיתה תחת הנק' של [?]] [?]

the point opposite Shemesh, aligned against [?] [נק' רום השמש מכוונת כנגד [?]] [?] and the apogees of the remaining stars [ורומי שאר הככבים [?]]

each one is called [?]; so its true place [כל א' נק' ה[?] כן מקומו האמיתי] [?] the beginning of the reckoning of its motion [התחלת חשבון מהלכו] [כי מהלך]

of the opposite point is the whole measure of the motion of the [apogee?] point that is in the sphere of [?] [הנק' כ"ל שיעור תנועת נק' [הק/רום שבגלגל ה[?]]]

epicycle, from its place onward [ההקפה ממקומו ואילך] · the second: the motion [הב' המהלך]

the mean is the measure of the motion of the diurnal sphere of [?] Shemesh, as above, as in chapter [14?] [השמש] [?] · the third: the motion of [?] [הג' מהלך מ']

of Shemesh, its meaning [?] for after [?] [כי לאחר ש] [?] [השמש פירושו ה] · the stars of the three spheres of Shemesh [?] [הככבים של ג' גלגל השמש]

L22–L28.

[?] the stars moving downward, like the motion of the sphere of [הככבים] [?] of degrees [המעלות] [?] to know [לדעת] [?] [חשבון מהלך הנוכח] the reckoning of the motion of the opposite point

from the mean motion, since [?] [הממהלך האמצעי לפי שכיין] [?] the opposite point [הנוכח], the motion downward like it [התנועה למטה כמוהו] [?] the motion was not [?] [לא נתן מהלך]

the mean; and it did not change from the motion of the opposite point [הנוכח] [?] the motion that it added to it, further [שנעלם] [?] [המהלך שהוסיף עליו יותר]

the motion of the opposite point from the mean motion; and what remains in the mean motion [המהלך האמצעי] [?] after this, the reason for it [?] [אחר הטעם זה ה]

here is what we wrote, to know [?]; and this is called the motion of the [?] of Shemesh [השמש] [?] [הנה שכתבנו לדעת] [?] [נק' מהלך מ'] · the fourth: the portion of the [?] of Shemesh, and this is the matter [הד' מנת מ'] [השמש והוא ענין]

of the difference set out above, as in chapter [14?] [השינוי שנת' למעלה כפי"ד] [?] [שיש כן מהלך האמצעי] · the fifth: the true motion, and this is [?] already [כבר] [הה' מהלך האמיתי וזה לפי כבר]

the going-out of the centre, as [?] there [יציאת המרכז כמו שם] [?] for [?] this difference is only up to the measure of [two?] degrees [כי [השינוי הזה אינו אלא] [עד שיעור ב/ג] מעלות]

f. 32v

Li–L8.

and a part, like the measure of [?] [?] [?] for when Shemesh [the Sun] stands opposite the point of the opposite, or the perigee [כי בהיות] [השמש כנגד נק' הנוכח או שפל]

the apogee to the [perigee?]: between the two points there are [one hundred and eighty?] degrees [הרום ל'שפל?] [יש בין ב' נק' ק/פ/ס] מעלות; which are [?] the sphere [הגלגל] [שהם]; there will be no [difference/equality?] at all between the two motions [לא [יהיה?] שום שינוי] [וי בין ב' המהלכים]

the mean and the true; and there is no [benefit?] in the reckoning [האמצעי] [?] [והאמיתי ואין ל'] [תועלת?] [חשבון] [ול' להוסיף] [א] [כל בשאר המקומות יש שינוי]

is the true. And in this way [?] we wrote [?] [שכת] [וכ[?] האמיתי · וכן[?]] [?] take the base date [נקח העיקר] [?] on [?] the sanctification of the new month [קדוש החדש]

and you will find [?] [?] for it [?] upon this base date [על זה העיקר], as posited [?], and begin your reckoning from [ותתחיל חשבונך מן]

the base date [?]; and this is its meaning [וזה עניינו] · here [?] [?] that the true place of Shemesh be at the beginning of the sign of [?] [להיות מקום השמש האמיתי] [?] [כתחילת מזל]

twenty-[four?] days, to know [?] [?] thousand and [?] [?] יום לדעת מ[?] כ[?]ד[?]
[?] which is [?] seventeen degrees [?] [?] שהוא ש' י"ז מעלות [?] the
[small?] [?] [?]הקטן [?] for [?] כי

L22-L28.

the mean motion of Shemesh at such a time [מהלך האמצעי של השמש לעת כזו] [?] one hundred and five[?] degrees, thirty-[seven?] parts, twenty-five[?] seconds [ק"ה מעלות ל"ז/ס חלקים כ"ה שניות], and the reckoning of

the motion of the opposite point at such a time [מהלך הנוכח לעת כזו] — [eighty-six?], forty-five[?], twenty-three[?] [פ"ו? מ"ה כ"ג]. Now subtract the opposite from the mean, and there remains [עתה תגרע הנוכח מן האמצעי ישאר] eighteen[?], fifty-one[?], two[?] [י"ח? נ"א ב']

[?] another [אחר]; and here, this [?] [יהנה זה] [?] [small?] [קטן?] the anomaly of [?] [ה] [מסלול?] of Shemesh [השמש]. Now take the equation of the anomaly already mentioned [עתה תקח מנת המסלול הנז']; and here

the reckoning of the anomaly was [?] degrees [חשבון המסלול היה כ?] [מעות] [?] and here its equation was [thirty-one?] parts [והנה מנתו היתה ל?] [א חלקים]; and since the reckoning of

this anomaly is less than one hundred and eighty[?] degrees [המסלול הזה] [?] do not add its equation [?] upon them, from the motion of [לא תוסיף מנתו למן] עליה[ם/ן] מן מהלך[?]

the mean itself, which is [?] [?] twenty-five[?] [[?] **עצמו שהוא ק**]; and there remains [וישאר] one hundred and four[?], fifty-nine[?], twenty-five[?] [**ק"ד נ"ט כ"ה**]; and [this is?] the true motion at the time [וזהו?] **המהלך האמיתי לעת**]

this; and a further rule [הזאת · ועוד כלל אחר]: that wherever you have in hand a number of parts or seconds [כי בכל מקום שיהיו בידך מספר חלקים או שניות] [?] you shall reckon [תתשוב]

f. 33r

Li-L5.

[?] [?] at all [כלל] for [כי] [?] [?] a degree [מעלה] [?] [?] [?] and not the reckoning of Shemesh [the Sun], and not in the manner of [כחשבון השמש] ולא [כחשבון השמש] ולא כענין :

[?] the parts will be more than a degree [יהיו החלקים יותר מעל'] [?] [?] [?] [?]
and they will be [ולהם יהיו]

[?] [?] will be more than a degree [יהיו יותר מעל'] [?] [?] a part [חלק] [?]

For every star there is no [?] to double the distance [לכפול] [?] — between the centre of the motion of the [?] [בין מרכז תנועה המהלך] and the centre of [למרכז]

the degrees [המעלות]. • And now let us set out the matter of the remaining [?] stars [ככבים] [ו/ז] apart from Shemesh [the Sun] [אשר יש להם גלגל ההקפה] [חוז מן השמש]

And [?] we correct the mean motion so that it be true [ו/ע/ש] [?] [?] Chamah [the Sun] [כחמה], which has no epicycle sphere [הקפה] [אשר אין לו גלגל ההקפה] [והי'] —

its correction in another way, as stated above, as in this chapter [תיקונו] [ב/כ] [אופן] • And let us set out the matter of the sphere [הגלגל] [אחר הנ"ל כפ' זה] [?] [Levanah] [the Moon] [הלבנה] and the motion [ותנועה] [?] for the rest of the stars [לשאר הככבים] —

and like the motion [וכמהלך] [?] [?] the motions of its spheres [מהלכי גלגליו] [?] • And it has been explained above in chapter [?] [?] [?] that the motion [כי המהלך] —

the true [motion] is the place at which it stands aligned in the sphere of the degrees [האמיתי הוא המקום אשר הוא מכוון בגלגל המעלות] [?] [?] or the star [או הככב] [?] [?] [כנגד מרכז]

[?] and not over against the centre of the epicycle sphere [ולא? כנגד מרכז] [?] [?] the eccentric sphere [כי הגלגל] [?] [?] [גלגל ההקפה] — that is to say [ל/ז] [?] the epicycle sphere [גלגל ההקפה] [?] [גלגל היוצא סובב ומניע]

fixed within it [הקבוע בו] [?] [?] which by its motion revolves [ישיעור כמה התנועה הגלגל היוצא] [?] [?] [אשר] [ב/כ] [תנועתו סובב גם אותו גלגל] —

the epicycle sphere along with it [ההקפה עמו] [?] a straight line [קו ישר] [?] [?] the eccentric sphere [מרכז גלגל ההקפה] [?] [גלגל היוצא] [?] [?] [ונדחק]

L26–L28.

a part of the motion [חלק מתנועה] [?] the centre [המרכז] [?] [?] [לפי] [שאינו לה גלגל הקפה] [?] [?] [שיש לה]

the epicycle sphere [גלגל ההקפה] [?] to us [לנו] [?] like the centre of its own epicycle sphere [כמרכז גלגל הקפתה] [?] [?] the star [הכוכב] [?] [?] [ומה ש] [?]

the mean motion of the [?] [מהלך האמצעי של ה] [?] [?] [עוד יש] [?] [?] [סיבוב גלגל ההקפה בו] —

f. 33v

L1–L8.

that the motion of the equation of Levanah [the Moon] is less than [?] degrees [שמהלך מנת הלבנה הוא פחות מ?] [מעלות] its epicycle sphere; and therefore one must know the equation of Levanah [לדעת מנת הלבנה] [צריך?]

standing at a degree closer to the degree [למעלה] [קרוב] יותר, and you will find [?] less [?] parts, and you shall take the measure of the true motion [פחות] [חלקים] ותקח שיעור המהלך האמיתי

the mean motion [מהלך האמצעי]; and if so, its measure will be [?] degrees [א"כ יהיה שיעורו] [ל?] [מעלות] and if the degree of the eccentric was more than [?] degrees [ואם מעלת ה] [יוצא?] היתה יותר מ?] [מעלות] —

(interlinear: מהלך [?])

for this is the place of the true [?] in the sphere of the degrees [כי זהו מקום] more than the mean motion of the centre of the epicycle sphere [יותר ממהלך האמצעי של מרכז גלגל ההקפה]

and it turns out that the centre of the [?] is closer to the [?] than [ונמצא שמרכז] [?] the mean [האמצעי], and they will be [?] degrees [וזה הוא מקום] [?] parts [חלקים] [ויהיו] [מעלות] [חלקים] [?] and this is the place [?] [ש]

And if so, one must add the equation of the eccentric to the mean motion [וא"כ צריך?] [?] the cause of the divergence of the true motion from the mean [סבת שינוי מהלך האמיתי מן האמצעי] [?] [ש]

the true [?] in the sphere of the degrees [ה?] [האמיתי בגלגל המעלות]; and this has been explained above [?] [?] [וזה נת' לעיל] [?] the equation of the eccentric, and therefore its correction is to know the equation of the eccentric [מנת היוצא] [?] [ולכן תיקונו הוא לדעת מנת היוצא]

[?] it is for the sake of the motion of the epicycle sphere, which is called [?] [?] [הוא לסיבת מהלך גלגל ההקפה הנקרא] [?] and to add or to subtract [ולהוסיף או לגרוע], and the mean motion according to the [?] [ומהלך האמצעי כפי ה]

[Margin: [?] — two marks in a non-body ink; recorded, not read]

L22–L28.

and to add or to subtract [ולהוסיף או לגרוע]; and the mean motion according to the [?] [ומהלך האמצעי כפי ה] [?] the lower one named [התחתון הנז'] — and if it is more than [?] degrees, or less [ואם הוא יותר מ?] [מעלות] או פחות [?] [ק?] [א"כ] [מעלות] או פחות [?]

and what the mean motion of the [?] will be, in degrees [ומה יהיה מהלך האמצעי] [?] [של ה?] [ב/כ] [מעלות] :

פרק ט"ז — Chapter 16[?]

After we have explained the two [?] — the mean and the true motions — which are found for every [ה?] [המהלכים האמצעי והאמיתי אשר נמצא לכל] [אחר שביארנו ב' ה?]

star [?] of the planets [כוכבי לכת] [ככב] [?] and what the correction of every star is [נבאר] [?] [ומה הוא תיקונו של כל ככב]

now the manner of the meeting of the two stars [עתה אופן פגישת שני הכוכבים] [?] [?] and we shall take the two luminaries, Chamah [the Sun] and Levanah [the Moon] [ולבנה] [ב' המאורות חמה ולבנה], for [?] [כי] [?] —

the principal [?] [עיקר ה] [?] as in the matter of the molados [כענין המולדות] and for the new moons [ולר' אשי חדשים], according to what [?] is written [יש] [כפי מה ש] [כתוב] [?] there is [יש]

it has two aspects [לה ב' בחינות] [?] as the mean motion [כמהלך האמצעי], and [?] as [?] [כמ] [?] the true motion [מהלך האמיתי]; and if [?] the true molad precedes it [ואם זה] [קדמונו מולד האמיתי]

f. 33v — outer (right) margin band

f. 34r

[Margin: ל"ד — the folio numeral, in the outer (left) margin of the recto, in the display size of the running header.]

F. 34R, LINES 1–9 (HEAD BAND)

[?] ... for the sphere [?] rises [?] ... the sphere of Levanah [the Moon] is [within?] the sphere of Chamah [the Sun], and above [?] ... for the sphere of the ha-m[z/']alos [גלגל המזעלות] — either ha-mazalos, the constellations, or ha-ma'alos, the degrees] revolves upon [?] ... both of them [?] ... Chamah; and the sphere of Chamah revolves upon the sphere of Levanah [?] ... for Shemesh [the Sun] itself is fixed [?] in the equinoctial line of the diurnal sphere, and [?] Shemesh is aligned and set opposite the equinoctial line that divides at the middle [?] ... the equinoctial line of the sphere ha-k[t]nah [גלגל הקטנה] [?] — see the QA note] and upon the epicycle sphere [?] ... fixed in the equinoctial line of the diurnal sphere, and the equinoctial line of [?] ... the degrees, a measure of [numeral: ?] degrees, [?] to know [?], and its motion [?] held back [?] opposite the breadth of the motion of the [?] [L8 ends כנגד רוחב תנועת, L9 opens המזעלות] ... [?] to be [?] the circuit [?] ... and Shemesh, [?] and [?]. And now, the motion —

F. 34R, LINES 10–22 (MIDDLE BAND)

The mean motion of Shemesh is the measure of the motion of the revolution of the diurnal sphere; and the mean motion of Yare'ach [the Moon] [?] is the measure of the motion of the revolution of the diurnal sphere [?] [numeral: ?]. The rest of their [?] spheres revolve from the west [?] ... to the motion; but the course of [?] the circuit, which is the measure of [?] the motion of the revolution of the sphere ha-k[t]nah [?], revolving [?] ...

and when Shemesh and Yare'ach [?] together, [?] aligned one [against?] the other [?] at a single point [?] — by way of example, that Shemesh and Yare'ach should stand at one point [?] ... and this is the time of the molad of Levanah [the Moon]; and in the language of the scholars of astronomy [?] ... and the explanation of the expression molad is this: it is known [?] that Shemesh is the

one that gives light [?], since it [?] has no light of its own — but if it strikes upon it [?] ... for all the light of Yare'ach is drawn to it from Shemesh.

And now: Shemesh and Yare'ach are like two round globes, the one [within?] the other, and the globe of Shemesh is larger than the globe of Yare'ach [?] ... giving light. And it has been demonstrated in the science of proof that when there are two globes set one opposite the other, and the one receives its light from its fellow, it does not illuminate in it more than the measure of half the globe — the half that faces it; and everything that stands farther from it [?] ... aligned opposite its face. It follows that [?] ... [?] the globe of Shemesh [?] ... the earth; for at the outset the first quarter of the sphere [?]

F. 34R, LINES 22–28 (FOOT BAND)

the earth; for at the outset the first quarter of the sphere [?] ... the globe of Shemesh [?] ... the lower [part], beneath the globe [?], and [?] the hour of [?] ... the molad [?] the first of the month, and the light [?] ... its lower part, the one that is visible to the inhabitants of the earth [?] ... it is above and is not seen; and from that moment onward [?] ... begins to withdraw from beside it [?] ... the motion; and behold, [?] the motion [?] — as [?] ... [numeral: ?] [numeral: ?], for this is the excess of Chamah [?] ... the month, [?] and from then on it gives light; so [?] ... to the inhabitants of the earth. This is why it is called molad; for [?] ... little by little, and from then on none of the light of the circuit [?] to the inhabitants of the earth [?] ... and it goes on growing until the circuit stands at the beginning of [?] the second quarter of the sphere, after [numeral: ?] days. And if there is, of the part —

f. 34V

F. 34V, BODY (LINES I–I4)

great between them. And if not, it gives light in this way — as to the half of it that faces us always, and in this there is no change whatever.

At no time [?] to the inhabitants of the earth. When it stands in the second quarter, there is not revealed to them of the light of the circuit anything except [?] ... in the fourth [?] when [?], and we draw out one line, straight, running from Shemesh [the Sun] to Yare'ach [the Moon] [?]; and it lights up those parts of it that face it. But to the inhabitants of the earth [?] there is not revealed a quarter of the lit globe of Yare'ach [?] ... and afterwards, in another [numeral: ?] days, once again the whole [?] ... the second quarter, as far as [?] the third quarter, which we spoke of [?] ... and now Levanah [the Moon] at fourteen days: it has drawn away from Shemesh [?] — the measure of half the sphere [?] — Shemesh at the utmost distance; and it stood aligned opposite it in every [?] ... another [?] of the sphere. And if it lights the half of it that is toward [?] ... toward its face, then with that half it is revealed in its entirety to the

inhabitants of the earth [?] like the globe of Yare'ach that we spoke of [?]; and in another [numeral: ?] days it turns back to draw near to it.

a measure like this [?], one sphere only — the distance between them; and if [?] it turns back and withdraws by a quarter of it, and the first quarter alone [?] ... it is the sphere. To the inhabitants of the earth [?] like the globe of Yare'ach [?] which we spoke of [?], at the beginning of the fourth quarter. And afterwards, in another [numeral: ?] days — which are the completion of [numeral: ?] days of the month — Levanah turns back to draw near and to cleave [?] ... the lower sphere [?] beneath one point [?], as at the beginning of the month; and it returns, hidden from all the inhabitants of the earth. And in this way [ועד"ן] it goes round again and again, from molad to molad, as at the first, every single month.

F. 34V — THE DRAWINGS

Diagram, the right-hand of the two drawings on the leaf. A large circle drawn in gold, with a black label running along its upper-left quadrant. Astride the top of that circle — its centre sitting on the circumference, so that the great circle's arc crosses it as a chord — stands a second gold circle; the letter alef is written inside it above the chord, and the word Shemesh inside it below the chord. Within the great circle a smaller gold circle is drawn concentrically, itself carrying a black label along its upper-left; astride the top of that circle sits a small gold circle whose lower half is filled solid blue, with Yare'ach written in black immediately above it. At the centre of the whole figure is a gold circle containing the word Eretz (the earth). A straight gold line runs down the vertical axis from the apex circle, through the small blue-bottomed circle and the central circle, and on to the foot of the great circle. Two further gold lines run obliquely from the apex circle down and to the right, meeting a small gold circle set on the inner circle in the lower right, whose right-hand portion is filled blue. Low on the vertical axis, a third small gold circle with its lower half filled blue sits astride the lower inner arc, with a gold line continuing from it to the foot of the great circle. Four single letters mark points on the great circle: alef at the top (inside the apex circle), bet at the right-hand extremity, gimel just below the lowest point, and at the left-hand extremity a fourth letter — see the note below.

- א (top, inside the apex circle, above the chord)
 - שמש (top, inside the apex circle, below the chord)
 - ירח (immediately above the small blue-bottomed circle on the inner circle)
 - ארץ (inside the central circle)
 - ב (right-hand extremity of the great circle)
 - ג (immediately below the lowest point of the great circle)
 - ד (left-hand extremity of the great circle) — [recte: ד] against this pass's ה [?], which is superseded and preserved verbatim in the QA notes below.
- A plain ד: a horizontal top bar with a small left serif and ONE leg descending from the bar's right end. See the QA note

- שמש[?]גלגל ה (running with the arc, upper-left of the great circle) — "the sphere of Shemesh", if the article sort is ה
- גלגל ירח (running with the arc, upper-left of the inner circle) — "the sphere of Yare'ach"

Diagram, the left-hand of the two drawings on the leaf. A large gold circle. Astride its apex sits a smaller gold circle, crossed by the great circle's arc as a chord, with the letter bet written in black immediately above it. Down the vertical axis below the apex circle stand two further gold circles, each with a small gold quatrefoil rosette drawn at its centre and a horizontal gold line through that centre: first a middle-sized circle, then a larger one. A long horizontal gold line runs across the lower part of the construction, and a row of small gold circles sits on it, each divided into quadrants by that line and by a short vertical. Reading from the left: a circle labelled Shemesh in black above it; then a circle labelled Yare'ach; then a larger circle; then a further circle; and at the right-hand end a circle with the letter gimel written in black above it, standing at the right-hand extremity of the great circle. Along the arcs in the lower part of the construction, black labels are written to follow the curve. No colour but gold is used, and no half-circle is filled.

- ב (immediately above the apex circle)
- ג (above the circle at the right-hand extremity of the great circle)
- שמש (above the first small circle on the horizontal line, at the far left)
- ירח (above the second small circle on the horizontal line)
- גלגל [?] הלכנה (running with an arc in the lower left) — first and third words read; the middle word, three or four sorts, NOT read
- גלגל [?] תחת[?] (running with a lower arc) — first word read, middle word NOT read, last word partly read
- [not read] a two-word group set at an angle below the horizontal line, left of centre: the lower word four sorts + three sorts, the upper word three or four sorts
- [not read] a two-word group set at an angle below the horizontal line, at centre: six or seven sorts in all

f. 35r

[Margin: לה — the folio numeral, in the outer (left) margin of the recto, at head level, in the display size of the running header.]

F. 35R, LINES 1–5 (HEAD BAND)

And we find that when the moon is directly beneath the sun ... at the time of the molad; that is to say, now ... [?] For [numeral: י"ד] fourteen days it [?] from beneath it, and it is found opposite it ... exactly, [?] the sphere [?] the other, and this is like the point [?] ... [?] and afterward [?], that is to say, that [?] ... like the point of [?] a new [?] — here it stands opposite it [?], and like the point [?] ... and Kochav [Mercury] [?] you know [?] ... balanced [?] at

the time of the molad, which are combined together; and above, it is born and renewed from below [?] ... [?]

F. 35R, LINES 6–15 (UPPER MIDDLE BAND)

which is the time of the [distance / conjunction?] between them, and [?] ... the explanation [?] of the expression molad — what it means; to explain [?] to you what it is ...

Know that when the moon is in its mean motion of its eccentric sphere — for that is the mean motion, as stated above — [?] and it meets with the sun in its [?] mean motion of its eccentric sphere. And it is known that the sun [?] is itself fixed in the eccentric sphere and has no epicycle sphere [?], whereas the moon is fixed in her epicycle sphere. And we find that then [?] the centre [?] opposite the sun itself, aligned with [?] the centre of her epicycle sphere and not with the centre of [?] ... the moon [?] itself: here, then, it is called molad — [?] the mean molad [?] ... [?] then it is called the true molad. [?] ... the matter of the two [?] moladot mentioned above, and they divide into [?] kinds of moladot. [?] when we draw out a straight line issuing from the centre of —

F. 35R, LINES 16–26 (LOWER MIDDLE BAND, RUNNING AROUND THE DRAWING)

— the earth, extending to the centre of her epicycle sphere [?], and it extends [?] to the centre of the body [?] of the sun; and it is like a thread [?] ... [?] the two motions are made equal, which are the mean motion of the sun and the mean motion of the eccentric sphere of the moon — but not the motion of the moon [?] ... [?] than the time of the moon [?], and then it is called the mean molad. [?] ... [?] and they fix [?] ... [?] and the mean motion of the moon [?] is called [?] ... because it is a [uniform / varying?] motion every day [?] ... [?] if we have established from now on that the motion of the sun together with the mean [?] motion of the moon is not a uniform motion — for —

F. 35R, LINES 27–28 (FOOT BAND)

— sometimes the [mean?] motion of the moon runs ahead, and sometimes it lags behind; and this is because her epicycle sphere is in motion [?] ... [?] and therefore we must know the mean molad, and afterward we shall explain the variation that there is —

F. 35R — THE DRAWING

Diagram. The drawing is inset into the lower half of the writing block toward the outer (left) side, and the leaf's lines 15 to 26 are shortened to run around it. A great circle is drawn in gold. A gold horizontal line runs right across it as a full diameter, carrying a black word at each end — *ma'arav* (west) at the right-hand end, and at the left-hand end a four-sort word whose final letter is not resolved (see the note below). Concentric with the great circle, and about six-tenths of its radius, a second gold circle is drawn; a black legend runs along the inside of its lower arc, and a second black legend runs along the outside of

the great circle's upper-left arc. At the common centre stands a small gold ring, with the words merkaz ha'arets — the centre of the earth — written in black on a radius running down and to the left from it.

Astride the top of the inner circle, so that the inner circle's arc crosses it, sits a small gold circle drawn as a wheel: a gold ring at its own centre, gold spokes running out to small gold nodes at its left, right and lowest points, and a further node where the vertical axis enters it from above. The node at its left is lettered bet, the node at its right dalet, and immediately below the lowest node stands gimel.

On the upper arc of the great circle stand three small circles drawn in opaque blue: a larger one centred on the vertical axis, and a smaller one to either side of it, all three set so that the great circle's arc passes through them. Each of the three carries the word Shemesh in black immediately beside it. The middle blue circle holds a small gold ring at its centre with gold lines radiating from it. From that ring a straight gold line descends the vertical axis, through the wheel-circle and on to the central ring and the foot of the great circle. Two further gold lines descend obliquely — from the left-hand blue circle to the wheel's bet node, and from the right-hand blue circle to its dalet node — and continue from those nodes down to the central ring, so that the three lines meet at the centre of the earth. One further black sort, larger and heavier than the point-letters, stands on the great circle's upper arc a little to the left of the vertical axis; it is not read (see the note below).

- שמש (beside the left-hand blue circle on the great circle's upper arc)
- שמש (beside the middle, larger blue circle, on the vertical axis)
- שמש (beside the right-hand blue circle)
- ב (the wheel-circle's left node)
- ד (the wheel-circle's right node)
- ג (immediately below the wheel-circle's lowest node)
- מרכז הארץ (on a radius running down and left from the central ring)
- גלגל יוצא של שמש (along the outside of the great circle's upper-left arc)
- לבנה[?] גלגל יוצא ד (along the inside of the inner circle's lower arc)
- מערב (right-hand end of the horizontal diameter, above the line)
- [ק/ח] מזר [?] (left-hand end of the horizontal diameter, above the line)

[Librarian note: 35]

f. 35v

F. 35V, LINES I–9

Since [?] the motion of the menas of Levanah [the Moon] מנת הלבנה — the moon's portion or argument; the second sort is not settled] [?] we make it the true molad, as we shall explain [?]. And when a straight line issues from the centre of the earth to the centre of her epicycle sphere — the moon's own — and on to the centre of the body of the sun, and it is like a [?] ... the point bet: then all the centres stand equal, and the three [?] motions have been made

equal — which are the mean motion of the eccentric sphere of the moon, and the motion of the moon's menas, and the mean motion of the sun; and then [?] it is called the true molad. And when a straight line issues from the centre of the earth to the centre [?] ... and on to the centre of the body of the sun, and it does not meet [?] the centre of her epicycle sphere [?] ... the motion of the moon's menas and the mean motion of the sun. But [?] they were not made equal [?] with the mean motion of the eccentric sphere of the moon — and it is a globe [?] — at the point gimel; and so [?] ... it is called the true molad. "

And now we shall explain [?] how it is right to [?] the knowledge [?] of the motion of the mean molad, as stated above, and we say [?] —

F. 35V, LINES 8–22

[?] by way of example [?], that the centres of the sphere of the moon, all three of them, were aligned at a straight point [?] opposite [?] ... and afterward they began to circle in their motion from the west toward the [east?] ... and we find that [?] the two centres [?] ... in every month [?] a measure like the mean motion of [?], because ... in every molad, as is known, [?] the menas of Levanah, which [?] ... for its motion is not equal to their motion, as is known [?] ... the moon aligned opposite them; and there are [?] two kinds of variation, for ... the centre of the moon with the centre of the body [?] of the sun, before [?] ... and sometimes the centre of the [?] of the moon meets the centre of the [?] ... the epicycle with the centre of [?], and therefore [?] ... as we wrote above, and we gave the measures [?] of her epicycle sphere ... the southern [?], the reverse of the motion of the eccentric sphere. And we find that —

F. 35V, LINES 22–28

for when the moon is at points [?] on her epicycle sphere, which is [?] ... alone [?], the point that is called the menas of Levanah, and the mean motion of [?] ... from [?] the mean centre, and [?] at the centre of the [?] of the moon ... at the place [?] [?] ⌘' and [?]; and now the two [?] motions of [?] ... the centre of the body [?] of the sun, for the moon was at an earlier [?] point [?] ... her epicycle sphere, and the two moladot were [?] at a single moment [?], and in every [?] ... and always only the west [?], to reach [?] as stated above; for so [?] —

f. 36r

[Margin: ל' — the folio numeral, in the outer (left) margin of the recto at head level, in the display size of the running header.]

F. 36R, LINES 1–8 (HEAD BAND)

— its motion [?] ... so as to return opposite us [?]. Here the mean molad does not run ahead of [?] the true one, because ... [?] when Shemesh [the Sun] [?] to the contrary, away from the motion of the [?] ... [?] as a lag [?], and [?] is great; and because [?] ... [?] the epicycle sphere of the moon [?] would

be [?] only the motion of Shemesh [?] ... and further, the eccentric sphere of the [moon?], whose motion is swift ... since [?] the epicycle sphere [?] like the swiftness [?] toward the side of [?] ... [?] and it is fixed [?] like the sun — for the motion of Shemesh is only [numeral: ?] parts each day, whereas the motion of the eccentric sphere of the [moon?] is 12 degrees and [numeral: ?] parts, and all that ... [?] the centre of the epicycle sphere [?] as far as the centre [?] ... at the time of [?] Shemesh, which in every [?] ... the mean molad ... and afterward it is displaced [?] from [?] the epicycle sphere by the motion of [?] ... at the time of Shemesh, and it stands opposite [?] ... and afterward [?] ... [?] the eccentric sphere gives the epicycle sphere a motion contrary to the motion of [?] ... opposite [?], and it draws near [?] ... at the time [?] that it was [?] —

F. 36R, LINES 8–22 (UPPER MIDDLE BAND)

— the eccentric sphere [gives] the epicycle sphere a motion contrary to the motion of [?] ... opposite, and the centre of the moon [?] also draws near ... at the time that it was [?] ... [?] the centre of the epicycle sphere, and it draws near to the centre of Shemesh; and that was [?] the true molad — after ... [?] the mean. And when the moon [?] moved further on, from point [letter: ?] to point [letter: ?], which is the nadir and the zenith [?] ... the centre, at the time ... the moon [?] and the centre of its epicycle sphere stand level on a straight line as far as [?] ... [?] with the centre of Shemesh, and the rest of the molad did not change [?] ... [?] the mean and the true, as stated above, when they stand at the time of the molad at point [letter: ?] ... [?] But when one of the places ... [?] the mean runs ahead of the true, since the centre of the moon [?] is [?] ... [?] and when it begins [?] to move a little [?] from point [letter: ?] to point **א**, and from point **א** to point [letter: ?] — in all ... [?] those places the true runs ahead of the mean, because the moon itself stands at [?] the centre of its epicycle sphere. And the reason for this is that when the point [?] ... [?] there the true and the mean diverge; but in every [case] where ... [?] the places, and their position relative to one another ... [?] when the moon [?] stood at the centre of its epicycle sphere, which is point ... [?] as far as point [letter: ?], by way of point [letter: ?] ... [?] their places, the mean to the true — and the moon is NOT [?] at the centre of its epicycle sphere ... [?] from point **א** to point [letter: ?], and from point [letter: ?] ... [?] they, the true to the mean.

And know that the moon [?] does not move away from Shemesh, as it circles its epicycle sphere, by more than a measure of 35 [?] parts; and that is the limit of the distance ... [?] that it be less than this, but not more ... [?] Therefore the limit of the distance between the two moladot is —

F. 36R, LINES 22–28 (FOOT BAND) — THE CLOSE OF CHAPTER 16 AND THE OPENING OF CHAPTER 17

[?] degrees [?] and parts.

פרק ט"ז — Chapter 17

I have already told you, in the chapter that came before, what the molad is [?] ... [?] and we have learned that the sphere of the moon [?] lies within the sphere of Shemesh. And when the two of them meet ... [?] that is to say, the body [?] of Shemesh itself together with [?] the moon herself, at a single point — [?] that is the time of the molad, and the conjunction [?]. There is no [?] change at all [?]. And when she has begun to draw apart [?] from above Shemesh and to incline to one side of it ... [?] she begins [?] to give light little by little [מעט אחר מעט] as far as her far edge [?] ... [?] a measure of half [?] the sphere, and she will be [?] ... [?] like [?] ... [numeral: ?] ... [?] —

[Catchword: לי/תח/ — three sorts. Sort 2 is ל (settled), sort 3 is י (settled — a short floating tick, about a quarter of a body sort's linear size, not a ב or ק), and sort 1 is narrowed to the roof-and-two-legs class, ה or ת, deliberately not chosen. This pass's חל/ב/ק is superseded and preserved verbatim below. See QA.]

f. 36v

F. 36v, LINES 1–8 (HEAD BAND)

— [?] the light of the moon [?] is renewed from Shemesh, and not [?] at the time of the [brightness?] ... [?] the globe of the earth [?] ... [?] all of them [?] between the time of Shemesh and the time of the moon [?], and she does not [?] ... [?] receives [?] a change of light [?] ... [?] and she is darkened, and this is called the eclipse of the moon [?] — as [?] ... [?] they are not [?] set opposite one another ... [?] does not give light [?] ... [?] from the darkening [?], as we shall mention [?] — everything above and below, as stated above. Now there is room for a question [?] ... at the time of the eclipse of the moon; and the answer is as we explained [?] ... [?] the light [?], which is renewed in every month ... [?] above, as in chapter [?] and chapter [?] ... [?] because Shemesh ... [?] of the eccentric sphere of Shemesh, when [?] the time of Shemesh ... [?] all of them aligned [?] from Shemesh ... [?] in the latitude of [?] [numeral: ?] degrees; but a [small?] line ... [?] of the eccentric sphere of the moon [?], whose epicycle sphere is fixed [?] in it — and likewise [?] of the epicycle sphere, fixed at the time of —

F. 36v, LINES 8–22 (UPPER MIDDLE BAND)

— [?] fixed in it; and likewise the equinoctial line of the epicycle sphere is fixed at the time [?] ... [?] itself. Here, then, it is inclined [?] away from the equinoctial line of [?] ... [?] the latitude of the motion of the [constellations / degrees?], because the eccentric sphere of the moon [?] ... [?] is fixed between the two poles of the sphere [?], and its own motion [?] ... [?] as stated above [?]. Now, half the equinoctial line of the sphere of the moon [?] ... [?] inclines to the north of the equinoctial line of the [constellations / degrees?], and the other half [?] ... [?] to the south; and the limit of the inclination is [numeral: ?]

degrees to the north ... [?] the line itself, and not from the [?]; and [numeral: ?] degrees to the [south?] of the line [?] ... [?] the equinoctial line itself, which in every [?] the motion, as stated above [?] ... [?] And indeed, the more the two lines draw near one another, the more they move together [?] ... [?] the inclination, its centre after its centre [?], until [?] ... [?] they draw near — and at the eastern point [?] and at the western point [?] — because it does not [?] ... [?] and the two equinoctial lines of the [touching / shining?] sphere of [?] draw apart ... [?] of the moon [?], and of the sphere of the [constellations / degrees?]; and there is no change in them at all. ... [?] and the point of the [?] of the [touching / shining?] sphere of the moon [?] ... [?] the point [?] is called the head of the [dragon?] or the Teli, and the [western?] point is called the tail of the Tanin [the dragon] or the Teli — and all the other stars [?] ... [?] the two points [?] ... [?] the aforementioned. There the two lines just mentioned draw apart from one another, and [?] ... [?] and they move in the likeness of a serpent and a dragon [?] ... [?] away from Shemesh [?] ... [?] and that separation [?] is called Tanin and Teli.

And here too the resembling sphere ... [?] its [?] is [?] in the likeness of the sphere of the [constellations / degrees?] ... [?] and among them it is called the serpent sphere; and its equinoctial line, and the equinoctial line of ... [?] of the [shining?] sphere, within which [?] move ... [?] there is the figure of a serpent and a dragon, one, with a head and a tail, as stated above; and therefore ... [?] the resembling sphere of the moon [?] is called the serpent sphere ... [?] among them — for when the matter of the Teli is mentioned [?] ... [?] by force of the change of the line of the [?] sphere away from it, and it is found [?] ... [?] for there is no dragon and no Teli at all [?], but only [?] — because [?] ... [?] small spheres [?], the resembling and the [?] —

F. 36V, LINES 22–28 (FOOT BAND)

— for there is no dragon and no Teli at all [?], but only [?] — because [?] ... [?] and within them [?] small spheres, which are the resembling sphere and the [shining / touching?] sphere ... [?] just as we said [?], as in chapter [?]. And know that when the two points [?] came ... [?] the aforementioned, the resembling sphere, and it alters [?] the course of the moon [?] ... [?] There the equinoctial lines of the [shining / touching?] sphere and of the eccentric sphere of the moon [?] cleave and join together, as stated above.

And let us return to the matter. The serpent sphere [?] of the moon [?] and the eccentric sphere of Shemesh — neither of the two of them inclines [?] away from the equinoctial line of the [constellations / degrees?]; but the sphere of the motion of [?] the moon [?] — its own equinoctial line inclines [?] away from the equinoctial line of the [constellations / degrees?]. And therefore, when Shemesh and the moon [?] are aligned together at the time of the molad, and the two of them stand at a single point —

f. 37r

[Margin: 𐤅 — the folio numeral, in the outer (left) margin of the recto, at the head level of the running header and in the header's display size.]

F. 37R, LINES 1–8 (HEAD BAND)

[?] they wrote [?] ... at point [?] ... and this they wrote [?] ... [?] aligned with [?] ... this, in a place where there is no [?] ... eclipse of Shemesh [the Sun] at all; and therefore [?] ... [?]. And the molad, when she stands beneath Shemesh, is not [?] an eclipse of Shemesh, because to our eyes [?] ... [?] the earth, since [?] interposes between the one and the other, and [?] ... [?] of its globe, when opposite it [?] ... the lower [?] ... as mentioned in chapter [numeral: ?], and [?] ... it is [?] the eclipse [?] — [?] it is because the globe of the earth interposes between Shemesh [?] ... [?] at all [?] ... the eclipse of Shemesh [?] ... [?] Shemesh, or she [?] ... more aligned, in one place other than [?] ... the two points of the Head and the Tail [?] ... [?] they are aligned below, in the manner of [?], they are near [?] —

F. 37R, LINES 8–22 (MIDDLE BAND)

— [?] they are aligned below, in the manner of [?] ... and they stand far apart one from the other. And therefore, whether at the time of the molad or at the time of the Tail, not one of them is eclipsed, since [?] ... [?] Shemesh [?] ... it is not from the [?] of the [?] ... [?] the molad; and likewise Shemesh [?] ... [?] the star [?] ... if it stands within the Tail and is hidden. For the eclipse of Shemesh [?] ... [?] is not complete at the time of the molad unless [?] the two of them are aligned at the point of the Head of the Teli, or the two of them at the point of the Tail of the Teli. And her eclipse is not complete unless [?] ... [?] when Shemesh and she stand opposite one another in exact alignment [?] ... one of them is found at its Head and the other at its Tail, or the reverse.

And so that you may know [?]: it is not [?] that Shemesh [?] ... and she stand at the point of the Head or of the Tail precisely. Rather, when it is within 12 degrees before the Head or after it, and when she is within 12 degrees before the Tail or after it — and [?] if she is [?] less than this measure — it must be [?] that she is eclipsed. But if she stands distant from the Head or from the Tail by 12 degrees or more, whether before them or after them, [?] the equinoctial line [?], she has no eclipse at all. And the closer she draws to the measure [?] ... toward the side of the Head or of the Tail, so the measure of the breadth of the eclipse grows greater [?] ... [?] and [numeral: ?] [?] ... For the measure of the cause of her eclipse we have already explained: it is according to [?] the globe of the earth, which interposes between Shemesh [?] ... [?] the globe of the earth, and she [?] —

F. 37R, LINES 22–28 (FOOT BAND)

— [?] she [?] ... when Shemesh stands on one side [?] of the globe of the earth and she [?] ... [?] the earth is drawn beneath [?] ... the side of its edge, as we

shall explain [?] in the place [?] ... when Shemesh [?] ... [?] the shadow of the globe is drawn downward, since [?] ... [?].

And the scholars of astronomy are divided as to the measure of the length of the shadow of the globe of the earth — how far it is drawn. For some say [א"י = ים אומרים] that its shadow goes on growing shorter [?] and is cut off [?] ... as far as [?] ... times [?] ... the sphere of [?], which is on the far side of the globe of the earth, and [?] ... it is hidden; for if the length of the shadow reaches as far as the sphere of [?] ... it is not cut off there. And [?] ... a place [?], when it reaches as far as the globe of [?] — then by the measure of [?] ... times, and [?] ... one time [?] by the measure of the diameter of [?] ... [?] the globe of [?]. And some say that [?] the shadow of the earth, when it reaches —

f. 37v

F. 37V, LINES 1-9 (HEAD BAND)

— as far as the globe of [?]. It is by the measure of [numeral: ?] times the diameter [?] ... and the thickness of the globe of [?], which is 84 parts, by the measure of the diameter of the thickness of the globe of [?] — it is 28 parts. [?] ... and it is because the shadow of the earth [?] ... [?] made from [?] ... as Shemesh gives light upon it [?] ... [?] and the one [?] ... for Shemesh revolves [?] ... [?] opposite the equinoctial line of the [?]; and it is found that the equinoctial line [?] ... [?] the line divides [?] the shadow of the earth [?] ... [?] half of [?], which is [numeral: ?] parts [?] ... [?] the equinoctial line, the line to its north and half of the shadow to the south [?] ... [?] when she stands at a distance of a measure of 12 full degrees from the Head of the Teli or from its Tail, before them or after them [?] ... for it is not certain [?] that [?] shifts toward the side of the Teli [?] ... [?] which is like the equinoctial line of the [?], [?] ... Shemesh [?] shifts from the line toward the side of the [?] —

F. 37V, LINES 9-22 (MIDDLE BAND)

— a measure of [numeral: ?] parts, [?] ... and it is found, from the equinoctial line of the [?], the [?] ... [?] at the middle [?] ... of the sphere of [?], which [?] — since there it stood fixed [?] ... [?] the breadth of the shadow of the earth, as we shall explain, as far as the equinoctial line [?] ... [?] the line cuts through the middle of the breadth [?] ... [?] half of it on this side of the line, and half of it on the other side. And here the premises stand correct [?] ... [?] for —

Now, when she stands at a distance of 12 degrees from the Head of the Teli or from its Tail, then she is now, from the equinoctial line [?] ... [?] which divides at the middle of the breadth of the shadow of the earth — a measure of [numeral: ?] parts — and as far as the equinoctial line that lies in the eccentric sphere [?] ... [?] the globe of [?], [?] a true diagonal [?], since the measure of the breadth of the shadow [?] ... they are [numeral: ?] times the measure of the globe of [?]; and behold, it is a breadth of 84 parts, which are [?] 28; and the half of the breadth is found [?] ... [?] the breadth of the shadow that lies

on the side of [?] is a measure of [numeral: ?] parts. And it is found, from the equinoctial line of the [?], toward the side of [?] ... [?] which is a measure of one time and a half [?], and it is hidden [?] ... [?] its middle, as far as the side of the globe of [?], and half the breadth of [?] ... [?] they are 14 parts from the shadow, and [numeral: ?] parts from the line [?] ... [?] the equinoctial line of the [?], which is set at the middle [?] ... [?] the breadth of the shadow of the earth as far as the line of the sphere of [?], the eccentric [?] ... [?] touching [?] together with the shadow of the earth, but it is not [?] ... [?] the earth; and she has no eclipse at all, according to [?] whatever it be [?] ... [?] of the [?] which is set toward the Head of the Teli, or —

F. 37V, LINES 22–28 (FOOT BAND)

— [?] from the equinoctial line of the [?] as far as the equinoctial line of the sphere of [?] ... [?] from its Tail, before them or after them; then there is nothing from the line [?] ... [?] which cuts through the middle of the breadth of [?] — a measure of [numeral: ?] parts, which are the measure of half the breadth of the shadow, which are [?] ... [numeral: ?] parts. The breadth of [?] is found [?] ... which are 14 [?] ... [?] and [?] ... [?] within the shadow of the earth — and behold, she is eclipsed. And according to the measure of the [?] ... [?] as she draws nearer to the Head of the Teli or to its Tail, all [?] ... [?] the breadth of her inclination grows less and the globe of [?] draws nearer, and it enters within the shadow of the earth; so that it is found that when she stands [?] ... [?] together with Shemesh, by the measure of [?] — this is found at the point of [?] at the Head of the Teli, and this at the Tail: the point where there is no —

f. 38r

[Margin: חל — the folio numeral, in the outer (left) margin of the recto, at the head level of the running header and in the header's display size.]

F. 38R, LINES 1–8 (HEAD BAND)

[?] the breadth of [?] ... and it is found that [?] ... and therefore [?] ... the shadow of the earth [?] ... the breadth [?] —

[?] the [?] standing on the [?] line of [?] ... and half the breadth of the shadow of the earth, and half the breadth of [?] —

[?] south of the equinoctial line, and half the breadth of the shadow of the earth [?] ... and half the breadth [?] ... [?] small [?] —

the equinoctial line, and [חל / חל] the whole [?] is eclipsed [?] ... the measure of the eclipse. And behold, [?] for you the figure of a globe [?] —

Shemesh [the Sun], standing on the line of the Teli [?] at its head [?] ... and a globe [?] standing on the line of [?] ... [?] —

the Teli, and how [?] then the whole measure of [?] is eclipsed, and all [?] ... [?] when it stands far from the line of [?], and so [?] ... [?] —

the measure of what is eclipsed [?] ... until [?] ... [?] the shadow of the earth [?] ... and behold, when she is distant 12 [degrees] —

[numeral: ?] degrees [?] from the tail of the Teli, for then [?] ... [?] [numeral: ?] minutes from the equinoctial line of the Teli as far as the line that divides —

[Librarian note: 38 — two modern pencil digits in the extreme outer (left) head corner of the leaf, set sideways, rotated about 90 degrees to the writing.]

F. 38R, LINES 8–14 (MIDDLE BAND, WITH THE PLATE)

— half her body, which are the measure of 42 parts of half the breadth of the shadow, and [י"ד] parts of half the breadth of her body.

And it is not completed [?] ... the shadow of the earth, and [?] is the [?] —

Diagram. A single construction filling the middle of the leaf, drawn in GOLD with BLUE washes and lettered in the scribe's black ink. There is no red on it and no gilded title above it; it is uncaptioned. Reading from the gutter (right) side leftward: a large gold circle stands at the right, crossed by a straight gold line that runs the full width of the leaf and passes through its centre. Two further gold lines, one above and one below, run tangent to that circle and converge leftward, closing on each other at the far left of the leaf — a shadow cone thrown to the left of the great circle. A second, slightly smaller gold circle stands within the cone about mid-leaf, centred on the central line. Two small gold circles, each holding a short label, stand outside the cone, one just above the upper line and one just below the lower line, to the left of the middle circle. At the narrow left end of the cone stand five small gold-rimmed circles: three filled solid blue, and two — one on the upper line, one on the lower — filled blue only in their lower half, each of these two labelled.

- צפון (above the upper converging line, right of centre): "north"
- דרום (below the lower converging line, right of centre): "south"
- כדור וף השמש [נ/ג] (inside the large right-hand circle, on the central line): "the globe of the body[?] of Shemesh"
- שלהבת אור השמש (in two lines, between the converging lines, right of the middle circle): "the flame of the light of Shemesh"
- כדור הארץ (inside the middle circle, on the central line): "the globe of the earth"
- ירח (inside the upper half-blue circle at the left end of the cone): "moon"
- ירח (below the lower half-blue circle at the left end of the cone): "moon"
- זנב התלי (in the cone, left of the middle circle): "the Tail of the Teli"
- [?] הארץ (in the cone, below and left of the middle circle): last word "the earth"; the four or five sorts before it are not read
- ואור (in the cone, below the preceding label, after a small mark): "and the light"

— And behold, [?] ... the sun at the point of the head of the Teli [?] ... and she at the point of the Tail [?] ... and [?] —

[?] ... the light of the sun [?] about half the globe of the earth, the half that is opposite it —

and there the light of the sun is cut off — (שתקע[ע/נ]) — and the shadow of the earth is drawn out over more than the other half of the globe of the earth —

[?] ... the light of the sun, and it remains in darkness [?] ... and in all [?] ... and the body of the sun is larger —

F. 38R, LINES 15-20 (FOOT BAND)

— than the globe of the earth by 166 times [קס"ו]; and the body of the moon is smaller than the globe of the earth, being one part in [numeral: ?] parts —

of the globe of the earth. I have also shown you how the breadth of the shadow of the earth [?] in its motion, and in the case of the moon it is [numeral: ?] times —

[?] the breadth of the body of the moon. I have also shown you how the breadth of the shadow of the earth [?] in its motion, and in the case of [?] ... when the moon is —

at the Tail of the Teli exactly, her whole body is eclipsed; and [?] must draw away twice the measure of her body before she comes out —

from within the shadow of the earth, toward the side of [?], in the north or to the south. And this is in the first Levanah [the Moon]; and in the second Levanah she has drawn away —

the measure of half her body from the line of the Teli. And if she is not eclipsed entirely, so that it is possible — and all of her — to come out from the shadow of the earth —

f. 38v

F. 38V, LINES 1-8

And in the third [?] [ה[ד/ג]]ל[?] — △ the side's opening word is NOT settled, and the rendering "Levanah" here is WITHDRAWN: it rested on **ובלכנה**, which is REFUSED at sort 4 on an in-word control. **ובלעדה** survives but is NOT confirmed, so no replacement is supplied. See QA] she has drawn away the measure of her whole body from the line of the Teli, and then only half her body is eclipsed. And in the [ordinal: ג/ד — third or fourth: ?] Levanah —

— that she is distant 12 degrees from the Tail of the Teli, and she has drawn away by a breadth of [numeral: ?] minutes toward the southern side, or —

north of the line of the Teli, then she is wholly full and there is no eclipse in her at all. And so [?] ... the smaller [?] ... the more —

[?] ... in the measure of the sphere [?] ... [?] —

And now I must tell you two things. The first is the measure of what is eclipsed of the surface of the body of the moon; and the second is the measure of the time

of her standing in [?] ... and the second depends on [?] ... [?] —

And know that the scholars of astronomy divided the breadth of the body of the moon into [numeral: ?]

Diagram. A single construction standing in the gutter half of the leaf, occupying roughly the vertical middle of the side; the body text of the eleven lines beside it is set short, running only in the outer half of the measure, and resumes full measure below the drawing. It is drawn in GOLD, RED and BLUE, and it carries NO LETTERING of any kind. A large gold circle encloses the whole figure. Within it, on the vertical axis: near the top, a chain of about seven small gold circlets set along a shallow arc; below that a RED circle, crossed inside by two straight gold lines that meet at its centre in an X; and below that, lower on the same axis, a BLUE circle. A straight gold line runs down the vertical axis through the centre of both the red and the blue circle, and two further straight gold lines run parallel to it, one on each side, from the upper arc down to the foot of the enclosing circle. Two more straight gold lines run obliquely from the upper part of the figure outward and downward, one to the lower left and one to the lower right, meeting the enclosing circle's arc. The whole is symmetric about the vertical axis.

- No labels. See the note below.

F. 38v, LINES 9-22

parts, and they are called 12 digits, although the diameter [?] —

[?] ... their breadths 28[?] parts as stated above; even so [?] ... or the 28[?] parts —

[?] ... 12 digits. And behold, when the moon stands at the point of the Tail of the Teli —

exactly, the centre of her body and the centre of the shadow of the earth are found [?] —

on the line of the Teli exactly, and half the breadth of the shadow and half the breadth of her body on the side —

[?] ... the line of the Teli, and the halves on the other side; and then the breadth [of the shadow] is drawn out —

toward the south, 42 parts, which are one and a half times the measure of the breadth of her body; and since the other half of —

[?] ... north of the line of the Teli, it is found that [?] ... and toward the other side, the smaller side, of her body, until it grows greater —

than the whole southern breadth of the shadow, which is twice the measure —

which are the measure of her inclination — a breadth of [numeral: ?] parts, as stated above [?] —

[?] ... [?] and the position of the moon, for from the surface —

[?] ... and as the breadth of the circle below the line of the Teli, toward its south, is —

[?] 84[?] parts as stated above; so too the breadth of the circle [?] —

of the Teli always, and in it as the measure of [?]; and it is found that when the centre —

F. 38V, LINES 23–28

— on the equinoctial line, and the centre of the body of the moon, when it stands at the point of the Tail of the Teli on the equinoctial line: then the whole body of the moon

is eclipsed. And half the breadth of her body south of the point of the Tail of the Teli, and half the breadth of her body north of the point of the Tail of the Teli. And likewise,

in the same way, half the breadth of her body on the [lower / upper: ?] side of the point of the Tail of the Teli, and half the breadth of her body on the upper side of the point of the Tail

of the Teli. And behold, the moon revolves in her eccentric sphere from above downward [?] ... as [?], and the measure —

of her motion, which is called the mean motion, of the moon, is [י"ב / י"ג: ?] degrees and [א"י / ג"י: ?] parts. And it has already [been said] that half the breadth of the shadow

of the earth, from the point of the Tail of the Teli — below it or above it, or to its north or to its south — is the measure of 42[?] parts

f. 39r

[Margin: ט"ל — two sorts with a mark above, standing at the outer (left) end of the head margin, in the running header's display size. Recorded as written, in the order the sorts stand.]

F. 39R, LINES 1–8 (HEAD BAND)

L1. ... which is one and a half times [?], and since [?] at the time it stands at the point of the Tail of the Teli, it follows that —

L2. the beginning of the breadth of [?], which is 14 minutes ... stands almost [?] at the point of the Tail of the Teli; and join it with —

L3. 42 parts of the breadth of the shadow, which [?] the point of the Tail of the Teli ... [?] [numeral: ?] minutes, a measure twice as great as —

L4. ... and it is found that until [?] the place where she stands at the Tail of the Teli, until a measure —

L5. twice the measure of [?], she has not come out entirely from the whole of the earth's shadow; but once she has moved the full measure —

L6. [numeral: ?] minutes, then she comes out of the earth's shadow entirely and has no eclipse at all. And behold, the measure of her motion —

L7. [numeral: ?] minutes is about the space of 2 hours; and it is found that when she is at the point of the Tail of the Teli she is hidden —

L8. For if half the breadth of her body [?] the point of the Tail of the Teli, which is 14 minutes, she must move the measure of —

F. 39R, LINES 9-22

L9. ... and a further 42 minutes besides, which lie between the point of the Tail of the Teli and [?] — in all, 56.

L10. ... minutes, which is twice [?]; and she is found standing in eclipse until she has moved a measure of 24 [?].

L11. ... which is twice [?], so that she comes out entirely from within the shadow. And behold, the measure of the hour of the place —

L12. of their eclipses is 24 [?], which are 50 minutes, when she stands at the point of the Tail of the Teli. But the measure of the duration of her standing —

L13. in eclipse depends on [?]; for behold, since the measure of the hour of the place of their eclipses is 24 [?], which are 50 —

L14. minutes, we must reckon the measure of her motion [?] —

L15. ... [?] and behold they are 2 hours approximately, [?] as far as [?] the point of the tail of the shadow [?] —

L16. and we must also reckon the measure of the motion of Shemesh [the Sun], how much it adds ... about two hours approximately; and behold you will find [?] that they are —

L17. ... parts; for Shemesh too is in motion and [?] ... [?] at the Head of the Teli, where it stood at that time, the beginning of —

L18. the eclipse; and she moves toward [?], since when ... the motions of Shemesh, and she [?] —

L19. at the point of [?] the motion — behold, she turns about from the side [?] to circle toward the east, and not [?] Shemesh [?] —

L20. ... turns about toward the side [?] ... the west; and so conversely, for the one always pursues the other —

L21. ... since the motion of both of them is equal [?], and they move ... eastward; and one must add and reckon the motion of Shemesh —

L22. ... for the motion of Shemesh too [?] ... [?] its place, and she inclines a little to come out from the earth's shadow —

F. 39R, LINES 23-28 (FOOT BAND)

L23. at the outset. And behold, what [?] the Moon and Shemesh [?] ... [?] far from the point of the Head of the Teli, and we reckon that so it moves —

L24. the measure of the eclipse out of the 24 [?], and it moves [?] ... the hours of the duration of her standing in eclipse; and so it goes on —

L25. [?] ... until it is found that when [?] ... the measure of Shemesh and the Moon, which correspond to one another —

L26. [?] except that they are [?] from the Head of the Teli, and you will find [?] ... a measure of 12 degrees, whether those before them or those after them —

L27. then there is no eclipse at all whatever, and the main point [?] ... for already she has no breadth [?] the distance of her inclination from Shemesh —

L28. [?] ... in respect of the breadth, with [?] ... when they are exactly together with them [?] this place, and the point of the equinoctial [?]

f. 39v

F. 39V, LINES 1-8 (HEAD BAND)

L1. As stated above. And we have already written [?] ... from the [?] to the Sages, of blessed memory [ל"ו], in order to know the measure of what is eclipsed —

L2. in eclipse; see there [וע"ש]. The rule that emerges is that there is no eclipse of the Moon —

L3. apart from [?] the measure itself, which is like half the darkening of Levanah [the Moon], which is like [?] ... [numeral: ?] —

L4. hours and [numeral: ?] parts. And with this [?] have written that Shemesh and the Moon will not be [?] far from the Head of the Teli —

L5. [?] the Tail [?], a measure of 12 degrees, found whether before them or after them; and [?] have also written, to inquire into —

L6. [?] ... like half the [?] of the sphere; for if [?] will not be —

L7. entirely, from the eastern and the western diameter of [?] ... although there will be an eclipse —

L8. [?] ... the eclipse [?] ... [?] of a city [?] —

F. 39V, LINES 9-14 (CLOSE OF THE CHAPTER)

L9. the Moon has not risen above the eastern horizon [?] ... and the [?] of theirs [?] far, and not [?] —

L10. hours; at the outset, the measure of [?] ... [?] as stated above; and [?] also [?] upward, for at the time of the [?] —

L11. it is not a true eclipse of the Moon, since Shemesh is not [?] ... so too [?] the globe of the earth [?] —

L12. between them is completed at the time of the [?], the molad, and not [?] ... although she is [?] and in [?] ... [?] —

L13. the inhabitants of the earth below, half a globe, and [?] ... the upper [?], for according to Shemesh she does receive light from —

L14. Shemesh — as stated above, at the head of the chapter — and therefore there is no matter of the molad [?] as with the eclipse of the Moon. :

פרק ח"י

L15. On the eclipse of Shemesh. It has already been explained [?] that there is no eclipse of Shemesh except at the time of —

L16. the conjunction [?], the molad itself, at the point of [?]; for the globe of the Moon's body is not [?] opposite Shemesh —

L17. [?] exactly aligned; and although she is [?] receiving [?] light from it, like the appearance of the [?] of the globe of [?] —

L18. as stated above in chapter [numeral: ?] [?] — behold, the Moon [?] the light of Shemesh, from lighting the globe of the earth. And so too the eclipse —

L19. of Shemesh. And behold, this is a [?] distinction between Shemesh and the Moon [?]: that the eclipse of the Moon is a true eclipse, for [?] —

L20. she has no eclipse [?] ... of the earth [?] ... for [?] every eclipse of Shemesh is —

L21. as we have written; for the inhabitants of the earth are not [?] to us ... receiving [?] from it; [?] Shemesh [?] —

L22. [?] ... at all, and there is no eclipse [?] to us. · And although it has been explained above [?] that [?] Shemesh —

F. 39V, LINES 23-28 (FOOT BAND)

L23. it is 166 times greater than the globe of the earth [קס"ו]; and the body of the Moon is one part in [numeral: ?] [?] of the globe —

L24. of the earth. And therefore [?] the small Moon [?] and covers Shemesh, which is greater than she is beyond all measure —

L25. But the matter is this: when the two globes stand aligned one with the other, the small will not cover the great —

L26. [?] entirely, Shemesh and the Moon one opposite the other, and [?] ... the other sphere above her, and there is a distance —

L27. between them, exceedingly great; and therefore, even if [?] ... the Moon, small as it is, being near, does not [?] hide and cover —

L28. Shemesh entirely from before our eyes, as has been explained [?] ... [?] that until now a small globe, the size of the [?]

f. 4Or

[Margin: ם — a single sort at the outer (left) end of the head margin, in the running header's display size.]

F. 4OR, LINES 1-7 (HEAD BAND, FULL MEASURE)

L1. ... the whole body of Shemesh [the Sun] ... and it has already been [?] that every single sphere is divided —

L2. ... [?] degrees, so that the degrees of the great sphere are larger than the degrees [?] —

L3. ... the degrees of the small sphere, which we wrote [?] ... [?] —

L4. ... all the spheres, which stand one inside another, and [?] —

L5. their division [?] into degrees and parts; and [the degrees and parts] of the outer, upper sphere will correspond —

L6. to the degrees and parts of the small sphere which we wrote; and as [?] —

L7. before you [?] ... the measure of the body of Shemesh; and [?] —

F. 4OR, LINES 8-15 (RUNNING AROUND THE FIGURE; SHORT MEASURE)

L8. Although the body of Shemesh is greater than the body of the moon [?] —

L9. ... [?], as mentioned above, the measure of [numeral: ?] [?] their measure, according to [?] —

- L10. the parts of its own sphere are a measure of 28 parts and 23 —
 L11. seconds approximately; and in this respect the body of Shemesh —
 L12. and the moon [?]; and [?] the body of Shemesh is —
 L13. 31 parts approximately, of the parts of its known sphere; and likewise [?] —
 L14. ... it was [?] [numeral: ?] parts approximately, of the parts of its sphere —
 L15. and it is found that although the parts of Shemesh are greater —

F. 4OR, LINES 16–21 (SHORT MEASURE, THEN FULL MEASURE RESUMES)

- L16. than the parts of [?], nevertheless they are equal, as [?] —
 L17. ... [?] —
 L18. all the spheres we have mentioned; and as stated in [?] ... eclipse —
 L19. just as the eclipse of [?] occurs at the time of [?] —
 L20. ... [?] that they be [?] —
 L21. one [?] and the other [?], or the reverse; so too in the eclipse of [?] —

F. 4OR, LINES 22–28 (FULL MEASURE)

- L22. beneath her at point **⌘**, and they do not change, neither in [?] nor in breadth; and [?] that both of them be equal together —
 L23. at the Head of the Teli, or [?] at its Tail, up to a measure of 6 degrees ... 6 degrees before them and not after them; and since [?] —
 L24. ... and in the eclipse of the moon [?] that they be 12 degrees, and in the eclipse of Shemesh [?] that they be 6 only —
 L25. ... and in the whole of them the [?] will be from the Head or the Tail ... and the Tail, 6 degrees; they have an inclination one from the other, and there is —
 L26. no eclipse at all; and [?] ... equal in all the motions and [?]; and this was explained above; and there is —
 L27. at every single molad an eclipse of Shemesh for every [?] ... it is only when, at the time of the molad, both of them are in the same place —
 L28. [?] of breadth, an inclination one from the other, and there is no eclipse of Shemesh there [?] ... as [?] in the eclipse of the moon above, there was no eclipse —

Diagram. A single circular construction in GOLD and ORANGE-RED, set into the outer-lower quadrant of the writing block, with the text running around it on the inner side. COLOURS PRESENT: gold and an opaque orange-red. No blue anywhere on this plate, and no brown-black drawn line — the ink lettering of the body stops at the figure's edge.

The construction, stroke by stroke:

- A large gold circle, drawn as an even outline, standing in the outer-lower quadrant of the writing block. It is the largest element of the plate and the measure against which everything below is described.

- A gold horizontal diameter running the full width of that circle, meeting the outer circle cleanly at both ends. On the leaf the line stands slightly proud of the circle at the left, and the join at the right is clean.
- A second, smaller circle in opaque orange-red, concentric with the gold circle — its radius a little under half the gold circle's. The horizontal diameter passes straight through it; the red stroke crosses the gold diameter rather than stopping at it.
- At the centre, a small gold ring or knot, sitting on the diameter, from which a fan of straight gold lines radiates. The fan fills only the upper half of the circle: every radius runs from the centre upward and outward to the outer gold circle, and no radius is drawn into the lower half. I count on the order of ten to twelve radii and I do NOT give an exact number — two or three of them run behind the small circles standing on the vertical axis and I could not separate them there.
- On the vertical axis above the centre, two further gold circles, both drawn as outlines and both crossed by the radii:
 - the lower, small, its radius about an eighth of the gold circle's — standing inside the red circle;
 - the upper, larger, its radius about three-tenths of the gold circle's — standing at the top of the outer circle, which its outline crosses, so that part of it lies inside the outer circle and part outside.

Labels: NONE. This is a positive finding of absence, and I made it only after reading every panel that carries any part of the drawing — fig1_p2, fig1_p3, fig1_p5, fig1_p6 — over their whole area, inside the circles, along the diameter, in the fan, and in the blank paper surrounding the plate out to the leaf's outer edge. There is no gold lettering, no ink lettering, and no mark of any kind that resolves into a sort. There is likewise no caption: nothing stands above, below or beside the figure, so `caption=None` is read and not defaulted. The only non-gold, non-red mark inside the drawn area is the feathered blot recorded above, which carries no letterform.

[Librarian note: 40]

f. 40V

F. 40V, LINES 1-9

L1. [?] will be at every time [?] ... that this eclipse [is reckoned] on a different day, from the time Shemesh is —

L2. and its rising on the [?] horizon of that city [?] ... the moon; for they [?] at a time when [?] has not risen above the horizon.

L3. ... that province, where it is night for them, and there is no [?] — no eclipse of Shemesh is visible to them except after them, as mentioned.

L4. And in every single province the time of the eclipse of Shemesh varies according to the division of the province, as above [?] —

L5. ... [?] as [?] [chapter: ?]. And now we shall explain the matter of [?] ... the eclipse of Shemesh, [?] further explanation —

L6. ... of the eclipse. It has already been explained that there is no eclipse of Shemesh unless [?] Shemesh [and the moon] are aligned together —

L7. at one point [?], both of them at the Head of the Teli, or that they have moved [?] ... at its Tail, in a place where they have neither distance —

L8. [?] nor distance of breadth; and [?] to them they will be [?] ... both of them [?] from the Head of the Teli or from its Tail, not —

L9. ... [?] and the measure of those degrees, as [?] ... how much length and how much breadth has risen from the [?] equinoctial line, the diurnal —

F. 40V, LINES 10–22

L10. ... [?] standing [?] the globe [?] where they meet [?] —

L11. And this is the explanation of their difference: behold, the province [?] ... and it has neither length nor breadth, as stated above [?], since the two —

L12. the equinoctial line and the meridian line — behold, the province [?] ... the city. And behold the circuit of Shemesh goes round by way of the equinoctial line —

L13. the lines mentioned [?] over the heads of its inhabitants [?] ... distance in their spheres, aligned [?] at the Head of the Teli, or —

L14. Shemesh, and when [?] ... together, opposite [?] from Shemesh, and it does not reach [?] —

L15. at its Tail — behold, they are not both aligned together [?] ... when the two of them are at a measure of 6 degrees before —

L16. ... from Shemesh, and [?] ... there is no distance of inclination [?] from Shemesh, and not —

L17. the Head or the Tail, or after them, and no more [?] ... the eclipse of the moon was explained above, [chapter: ?], that they are at a measure of 12 —

L18. there is an eclipse of Shemesh; and since we wrote [?] ... it is there, because the cause of that eclipse was like the cause of the shadow —

L19. degrees; and there is an eclipse in which some of them [?] ... times the measure of the breadth of the moon, and therefore up to a measure of 12 —

L20. the earth, which interposes [?] ... it was 3 parts, and she does not come out from within the shadow, and not [?] —

L21. degrees; for with the measure of the breadth [?] the distance [?] ... the cause [?] only when [?] —

L22. From this [?] here, in the eclipse of Shemesh, there is no [?] ... it is when she is 6 degrees distant from the Head of the Teli, or —

F. 40V, LINES 23–28

L23. ... Shemesh; and therefore the measure of the distance of her inclination [?] ... when she is in that place, it is 28 parts and 23 seconds —

L24. from its Tail — only at the measure of her inclination when she is [?] ... as above, in the manner explained above concerning 3 parts. And behold —

L25. at the measure of half the body of Shemesh and half the body of the [moon] [?] ... at the time when they are at the point of the Head of the Teli or its Tail; and this [?] —

L26. for behold, the distance of the body of Shemesh and the distance of [?] ... [?] in breadth; and now, that they are 28 parts and 23 seconds —

L27. ... the moon, to separate from Shemesh by the measure of [?] ... and therefore, at the measure of the distance in length of 6 degrees from the Head —

L28. and as mentioned, there is no eclipse of Shemesh at all [?] ... [?] the breadth of her body, and Shemesh is not covered by her at all.

f. 4Ir

F. 4IR, LINES 1–5

L1. And behold, the rest of the [?] — for those [?] which have [?] in length and [?] —

L2. — and not breadth; or for those which have breadth and not [?] [?] —

L3. [?] ... [?] her [?] and [?] from the [?] mentioned [הנו]; and behold, since already [?] —

L4. — for when she is in the south[?] of the degrees she is [?], and inclines away from Shemesh toward the south; and when she is —

L5. — in the [?] of the degrees, inclining away from Shemesh toward its north[?] — because Shemesh does not incline at all from its [?] equal circle.

F. 4IR, LINES 5–15

L5 (continued).

L6. — of the sphere of the [degrees / constellations][?], at all, ever. And it is also seen by the sense of sight, for when she is beneath Shemesh —

L7. — [?] — even so [עכ"ז], the distance being very great, so the upper to the lower, as stated above [כנ"ל]; for [?] in sphere [numeral: ?], and this in sphere —

L8. — [numeral: ?]. Behold, if the place where it stands is [?] ... according to her [?]; the [?] mentioned [הנו], [?] and not —

L9. — the [?] of Shemesh [?] ... when the sense is strong, like the appearance of [?] that has breadth toward the [?] side, and [?] star [?].

L10. And even if it is beneath Shemesh it diminishes, since there is a great distance between them; and behold the [?] — the distance stands —

L11. — [?] the small[?] side, [?] hidden; for if it be, it will be [?] the breadth [?] the breadth of the [?] of the degrees[?]; and behold [?] —

L12. — and it distances her from Shemesh toward the south, and [?] diminishes, since she [?] — distanced. And if it were in the small breadth ·

L13. Behold, [?] [?] distances her from the small[?] and [?] her [?] toward Shemesh when [she is] in the south; and if it were —

L14. — beneath Shemesh, even so [עכ"ז] it distances her from beneath it, and [?] — inclining a little toward the south; and if the degrees[?] toward —

L15. — the south, [?] the whole, when [?] as mentioned [כִּנּוּ], [?] ... [?] when the degrees[?] which have [?], for [?] —

F. 4IR, LINES 15–25

L15 (continued). — [?] diminishes [?]. Behold, [?] when the degrees which have [?], for [?] —

L16. — that [?] that degree [?], the point [הִנְקוּ], when [?] ... aligned, she being beneath Shemesh at the time of the —

L17. — [?]. And behold, the sense of sight of the eye [?] [?] from beneath Shemesh, and no eclipse [?] [?] to them —

L18. — therefore the Sages instituted to say "and its measure," and so forth [וְכוּ]; all [?] the [?] the places. From this, to fix the time of the eclipse that will fall in every —

L19. — each and every degree, each one according to the measure of the variation of the [?] ... the [?] fitting[?], as mentioned [כִּנּוּ]; and the near [?] the diminution[?] of the stars —

L20. — as stated above [כִּנּוּ]; for by means of [ע"י] the [?] of the eye the place [?] varies — according to the sight of the eye there, and not according to the truth. Therefore —

L21. — we shall explain. The matter of the degrees divides, when the height of [?] ... the height[?] of their small horizon is [?] than the measure of —

L22. — degrees, up to a measure of height of [numeral: ?] degrees [?] ... [?] there is the principal inhabited region. And behold [?] —

L23. — the breadth of the first clime, as stated above [כִּנּוּ] [?]. And behold, [?] degrees [?] that in all the [?] of the horizons mentioned [הִנּוּ], [?] —

L24. — [?] of the breadth are southern, since in all the [?] of the year Shemesh is southern to them, to all —

L25. — like the rest of the degrees, when the height of [?] the small is [?] less than 24 degrees, where Shemesh —

F. 4IR, LINES 26–28

L26. — is southern to them in the days of the [?], and it too is small [?] ... to them in the days of the summer [הַקִּיץ]. Behold, there [?] —

L27. — for sometimes they will have a variation of the [?] breadth [?] ... small ones, and sometimes southern[?] · And behold, if —

L28. — there will be an eclipse [לְקוּת], [?] the [?] — one must make the [?]: the correction [הַתִּיקוּן] opposite to the correction made in the degrees.

f. 4IV

F. 4IV, LINES 1–8

L1. [?] — 24 degrees, and up to degree [numeral: ?] [?] ... [?] their matter[?]. And behold, we have no [?] at all [?], for those —

L2. — the [?], and we shall explain in the degrees: [?] 24 degrees, and up to degree [?] degrees · And it will begin [?] Jerusalem[?] —

L3. — [?] the breadth[?] is 32 degrees, and [?]. And [?] ו"ל has already made a table [לוח] of the variation of the [?] —

L4. — [?] for the [?] of Jerusalem[?] [?] ... as [?]. And behold, it has been explained [נת] that in every [?] the breadth —

L5. — from 24 up to degree [numeral: ?] [?] the fixed [?] like the breadth [?] ... is always [?]; behold, [?] southern, [?] the breadth ·

L6. — [?] that it is not possible for her to have a breadth small[?] [?] ... [?] small[?] of Shemesh and the degrees; or the breadth will be —

L7. — southern, to the south of Shemesh and the degrees. And behold, when — when her breadth is north[?], there are distinctions in this —

L8. — And behold, if she is very near to the [?] Head of the Teli or its Tail, [?] that the variation of the [?] —

F. 4IV, LINES 8–22

L8 (continued). — [?] — for the variation of the [?] —

L9. — will be small; and since, if it be great, [?] the sense [?] ... the eclipse [?] will not be beneath Shemesh —

L10. — very much, and there will be no eclipse [ולא יהיה לקות]. And if she is distant [?] ... from the head [?] or from its tail, [?] that it will be the opposite of —

L11. — the [?] mentioned [הנני], and that the variation of the breadth be somewhat great [?] ... for when she is distant from the Head or the Tail, as stated above [כנ"ל] —

L12. — the breadth of her inclination from Shemesh; therefore it is necessary that [?] ... the variation of the [?] be great, so that [?] the eclipse —

L13. — [?] her toward the south, to the side of Shemesh, and thereby [ועי"כ] [?] ... the eclipse is seen, and so forth [וכי]. And if the variation of the [?] be small —

L14. — and her breadth will always [לעו] be great, so that the variation of the [?] ... [?] her toward the south, there will be a slight approach —

L15. — and she will not appear beneath Shemesh, and [?] ... the eclipse will not be seen [?], when her breadth is —

L16. — southern, it will not be the opposite of all that is mentioned [הנני], since [?] ... [?] removes her further toward the south, and she grows more distant —

L17. — from Shemesh, which is in the [?]; therefore the breadth must be small — that is to say [ר"ל], that she is near the head[?] —

L18. — the small[?], or to its tail, and a small breadth; and likewise the variation of the [?] will be so small that it does not distance her [ירחיקנה] from Shemesh —

L19. — toward the south, and the eclipse diminishes · And after we have [?] this premise, let us now return to the matter of Jerusalem[?] [?] —

L20. — for the breadth of the variation of the [?], when [?] there the greater [?] ... [?] great it is, when Shemesh is at the head[?] of [?], for there [?] is hidden —

L21. — Shemesh [?] more [?], and near to the south [?] ... the [?] of the approach [?] in the [?] of the day, the [?] of the breadth of the variation of —

L22. — the [?] are [numeral: ?] minutes [דקים] and [numeral: ?] seconds [שניות], and they are [?] ... [?] parts, according to [?] Shemesh; and it was as stated above [כנ"ל]. And behold —

F. 4IV, LINES 22–28

L22 (continued). — [?] parts, according to [?] Shemesh; and it was as stated above [כנ"ל]. And behold —

L23. — they will be degree [numeral: ?] and [numeral: ?] chalakim and [numeral: ?] seconds; and [?] her [?] breadth [?], and she grows distant, for —

L24. — the measure of the breadth of this inclination is, when [?] ... [?] the degrees from the head of [?] or from its tail, further [עו'] —

L25. — degrees and [numeral: ?] chalakim and [numeral: ?] [?], [?] for when [?] ... [?] a northern breadth, as stated above [כנ"ל], from the beginning of the degrees up to —

L26. — the end of [numeral: ?] degrees, [?] from the head of [?] up to [?] ... its tail, [?] since they are northern degrees, [?] for the sense —

L27. — of sight brings her near [?] chalakim; and if she be [?] her measure, which is 28[?] chalakim and 23[?] seconds — therefore [?] —

L28. — that the sense of sight brings her near and makes her seem [?], as if she were wholly beneath Shemesh, and there will be an eclipse [?].

F. 4IV — THE MARGINAL GLOSS (RECORDED, NOT READ)

[Margin: a marginal gloss in lighter, tan ink stands in the outer (right) margin of f. 4IV, beside body lines L21–L26 — three lines of writing and one further short stroke. Whether it is a second hand or the same hand with another pen is left open. Its content is not transcribed.]

f. 42r

F. 42R, LINES 1–5

L1. [?] will be [?] the distance more than [?] degrees, and [?] ... [?] the measure[?] [?] more [?] will be [?] —

L2. — and we have already explained [וכבר ביארנו] that in [?] the [?] of the variation of the [?] [חילוף ה'] is only up to [numeral: ?] [?], and no more —

L3. — [?] there remains more [?] [?] and [?] seconds [שניות], and [?] —

L4. — the eclipse [לקות] of [?], since the [?] of the distance is [?] ... not [?] —

L5. — [?] Shemesh; therefore, if the variation of the [?] [חילוף ה'] be small[?] at all, and [?] ... there will be an eclipse[?] —

F. 42R, LINES 5–16

L5 (continued). — and also [וגם] [?] the breadth[?] be small, there will be an eclipse[?] —

L6. — [?] that now it is necessary [צריך] that we [?] ... the [?] of the smallest distance of them all [המרחק היותר קטן שבכולם]. And behold, when —

L7. — Shemesh [?] ... they are near[?] [?] the inhabitants of [יושבי] [?] [?] small[?], and the variation of the [?] [חילוף...] —

L8. — [?] ... [numeral: ?] minutes [דקים] only [בלבד]; and since [?] the variation of the [?] —

L9. — [?] ... [numeral: ?] minutes [דקים] and [numeral: ?] seconds [שניות] of Chamah [the Sun]. ·

L10. [?] Shemesh [?] ... and there remain [וישארו] [numeral: ?] minutes [דקים] and [numeral: ?] seconds [שניות], and [?] ... as we have done [כמו שעשינו] —

L11. — [?] the breadth [רוחב] [?] ... [?] that the breadth —

L12. — the head of [?] [ראש...], or beneath it, [numeral: ?] degrees and [numeral: ?] minutes [דקים]; and [?] —

L13. — [?] and [numeral: ?] [?] of breadth[?]; and [?] — this is the rule [זה הכלל] —

L14. — [?] the variation of the [?] [חילוף...], since[?] all of them do not exceed [לא יעברו] more —

L15. — [?] minutes [דקים] and [numeral: ?] seconds [שניות], which are [numeral: ?] degrees[?] [?] parts [חלקי] [?] —

F. 42R, LINES 16–26

L16. — the distance [numeral: ?] degrees and [numeral: ?] minutes [דקים]. · The rule that emerges [הכלל העולה] is that [?] ... the eclipse [הלקות] for Jerusalem[?] [?] is [?] —

L17. — the luminaries[?] [המאורות] are distant[?] from [?] [numeral: ?] degrees [numeral: ?] minutes [דקים], up to [?] ... measure[?], [numeral: ?] [?] around[?] the tail of the Teli[?], or from —

L18. — [numeral: ?] ... up to [numeral: ?] degrees [numeral: ?] minutes [דקים] [?] ... around[?] the head of the Teli[?]; and [?] the small ones are [numeral: ?] degrees —

L19. — [numeral: ?] minutes [דקים], and likewise[?] [numeral: ?] degrees, [numeral: ?] degrees [numeral: ?] minutes [דקים]; and [?] ... the southern ones [הדרומיים] are [numeral: ?] [numeral: ?] [numeral: ?] ·

L20. And if you wish [ואם תרצה] to give [?] the eclipse [הלקות] of every [?] — horizon [אופק] and horizon, from the rest of the [?] [?] —

L21. — [?] from [numeral: ?] degrees, where[?] [?] ... small[?]; when Shemesh is there she passes[?] over their heads [ראשם], and up to —

L22. — [numeral: ?] degrees, which is the principal inhabited region [עיקר הישוב], as stated above [כנ"ל]; for [?] ... the places [המקומות], and further[?] according to[?] the variation of the [?] [חילוף...] of the breadth[?] —

L23. — [?] always [לעולם] [?], since [לפי] Shemesh will always be [?] ... to them throughout the year[?]; and to know[?] [?] the eclipse [הלכות] of —

L24. — every single horizon [אופק ואופק] of them [?] ... this. · Behold, [?] ... already [כבר] [?] composed [חיבר] [name: ?], of blessed memory [ז"ל], on —

L25. — Jerusalem[?] a table [לוח] of the variation of the [?] [חילוף...]; and behold, from [?] you can know [תוכל לדעת] the rest of the variations of the [?] for every horizon[?] —

L26. — [?] Behold, if [?] ... or a horizon [אופק] less than the latitude [רוחב] of Jerusalem[?], which is [numeral: ?] degrees, [?] —

F. 42R, LINES 26–28

L26 (continued). — less than the latitude [רוחב] of Jerusalem[?], which is [numeral: ?] degrees, then[?] —

L27. — for each and every degree [לכל מעלה ומעלה] [?] ... more[?] than the measure[?] of the variation of the breadth[?] of the [?] of Jerusalem[?], in all[?] the [numeral: ?] —

L28. — degrees; and if [?] your horizon [אופקך] be more than the latitude [רוחב] of Jerusalem[?], you shall do[?] the opposite[?] [?] [?] —

F. 42R — OUTER (LEFT) MARGIN: THE GLOSS

[Marginal note: an eleven-line gloss in a second, thinner, greyer hand stands in the outer margin of this recto, beside body lines L17–L28. Its content is not transcribed here — see the QA record below for its measurements, and the reasons no word of it is offered.]

[Librarian note: 42]

f. 42V

F. 42V, LINES 1–9

L1. [numeral: ?] for every degree [לכל מעלה], and [?] ... upon the measure of the breadth of the [?] ... of Jerusalem[?]. And behold, this I have written[?] [כתבתי] · it is that [?] —

L2. — the variations[?] of the breadth of the [?] [חילוף רוחב...] of Jerusalem[?] will be from [numeral: ?] minutes [דקים] up to [numeral: ?] minutes; and [?] ... if they be degrees, and up to [numeral: ?] —

L3. — will be [?] [numeral: ?] for every degree and half a degree[?], the near[?] [?] ... if it adds, or if it falls short[?]; and from [numeral: ?] up to [numeral: ?] it will be —

L4. — [?] [numeral: ?] for every [numeral: ?] degrees. · Only[?] [?] ... behold, in[?] Jerusalem[?], which is [numeral: ?] degrees, when Shemesh is [?] —

L5. — they were all[?] the variation of the [?] [חילוף...] up to midday[?], which are [?] ... [numeral: ?] hours [שעות] and [numeral: ?] minutes [דקים]; they were [numeral: ?] minutes, the variation of the breadth [חילוף רוחב] —

L6. — and in every horizon [אופק] [?] ... breadth[?] [?], where there is a circuit[?] of [numeral: ?] degrees; and they are half the day[?], [numeral: ?] hours and [numeral: ?] minutes; they will be [?] —

L7. — the variation of the breadth [חילוף רוחב] [numeral: ?] minutes [דקים], since we add[?] for every degree — a degree and a half[?], [?] only[?], since the minutes[?] are degrees[?] and up to [numeral: ?], as stated above [כנ"ל] —

L8. — and now[?] you can make [תוכל לעשות] for all the horizons [האופקים] as the breadth[?] [?] ... the distance[?], do not be so concerned [לא תחוש כ"כ], for [?] —

L9. — only[?] that it hold [numeral: ?] by the reckoning [כחשבון] · and [?] for [?] ... to be the variation of the breadth [חילוף רוחב] more than [numeral: ?] minutes [דקים] in any other place [בכל מקום אחר] —

F. 42V, LINES 9–22

L9 (continued). — [?] ... to be the variation of the breadth [חילוף רוחב] more than [numeral: ?] minutes [דקים] in any other place [בכל מקום] [?] —

LI0. — [?] ... this: how you are to find[?] or bring out[?] the [?] for every

—
LI1. — degree, or for every [numeral: ?] degrees, as stated above [כנ"ל]. And if you seek [ואם תבקש] the variation [החילוף] —

LI2. — [?] ... more[?] [?] where there is [?] ... when Shemesh is there, as at first[?], and you take[?] how many minutes [דק'] the variation —

LI3. — [?] ... and [numeral: ?] seconds[?] [שניות / שניים], which are [?] halves[?] according to[?] [עפ"י] Shemesh; and it is —

LI4. — [?] ... and there comes out for it[?] how many degrees and minutes [ודקים] of the limit[?], from the limit [חק] —

LI5. — [?] ... and they themselves are [?] the limit of the distance [חק המרחק], the small ones [הקטנים] —

LI6. — [?] ... which there is in every horizon [בכל האופק], the [?]; and it is when Shemesh —

LI7. — [?] ... from [numeral: ?] minutes [דקים] and [numeral: ?] seconds[?] of halves[?] according to[?] [עפ"י] —

LI8. — [?] ... the one required[?] [המתחייבת], and there comes out for it[?] how many degrees and minutes, from —

LI9. — [?] ... which it enters into[?], and they themselves are [?] the limit of the distance [חק המרחק] —

L20. — [?] ... as we have done [כמו שעשינו] for the city of Jerusalem[?] [לעיר ירושלים], as stated above [כנ"ל]; and if they are —

L21. — [?] ... in all the horizons [בכל האופקים], as mentioned[?] [כנו], [?] and up to [?] degrees[?] [?]; they are from the —

L22. — [?] ... it is possible that there is an eclipse [לקות] for every place [מקום]; and behold[?], not —

F. 42V, LINES 22–28

L22 (continued). — [?] ... it is possible that there is an eclipse [לקות] for every place [מקום]; and behold[?], not —

L23. — there is [?] an eclipse [לקות] [?] ... horizon [אופק] of them : And behold, what emerges from all the above [העולה מכל הנ"ל] is that there is [?] ... that there is in it —

L24. — the opposite [להפך]; and there is one that will be as in length[?] [כאורך] and as in breadth [וכרוחב], and [?] ... [?] —

L25. — [?] ... because of the greatness of their [?] and their height[?] [וגבהם], no variation [חילוף] falls upon them —

L26. — [?] upon them the variation of the [?] [חילוף ה...], and it begins to make an impression[?] [ויתחיל לעשות רושם] —

L27. — [?] ... than the rest of the lower ones[?] [התחתונים]; and when they are at the zenith[?] [ברום] of its distance[?] —

L28. — [?] [numeral: ?] minutes [דקים]; and it was[?] [?] the variation of the [?] [חילוף ה...] is great[?] —

verbatim below. Two sorts, כ + ה (roof, right leg, detached left leg). The external check against f. 43r's first word has now been RUN and it passes: f. 43r opens כה. See QA.]

f. 43r

F. 43R, LINES 1–4

L1. — thus ... it rises[?] [תעלה], because she is nearer[?] [קרובה] [?] ... and behold [והנה] [?] the variation of the [?] [חילוף הה] [?] —

L2. — [?] ... the horizon [האופק]; when she is [כשתהיה] [?] ... the apogee of her distance [רום מרחקה] in the eccentric sphere [בגלגל היוצא], and if[?] [ואם] as the apogee of her distance [כרום מרחקה] —

L3. — in the sphere of her epicycle [בגלגל הקפתה] [?] the variation of the [?] [חילוף הה] [?] [numeral: ?] ... and when she is [כשתהיה] as the apogee of her distance [כרום מרחקה] from the sphere[?] [מגלגל] —

L4. — the eccentric [היוצא], and when the apogee of her distance falls[?] [וכשתפל רוֹם מרחקה], the near one [הקרוב], in the sphere of her epicycle [בגלגל הקפתה] [?] the variation of the [?] [חילוף הה] [?] ... [numeral: ?] degree[s][?] [מעלה] —

F. 43R, LINES 5–14

L5. — [numeral: ?] [?] and upon[?] [ועל] the minutes[?] [הדקים] [?]; and when she is [כשתהיה] [?] when the apogee of her distance falls[?] [וכשתפל רוֹם מרחקה], the near one [הקרוב] [?] and like[?] from the eccentric sphere [מן גלגל היוצא] and from[?] the sphere of her epicycle [גלגל הקפתה] —

L6. — [?] ... [numeral: ?] degree[s] [מעלה] [numeral: ?] and [numeral: ?] minutes[?] [דקים], and further[?], because always [כי לעולם] [?] ... [?] the

eclipses[?] [הלכות]; Levanah [the Moon] stands [עומדת הלבנה] at the far distance [במרחק הרחוק] —

L7. — [?] as the apogee of her distance [כרום מרחקה] from the eccentric sphere [מן גלגל היוצא], and to the whole reckoning[?] [לכל חשבון] of the sphere of her epicycle [גלגל הקפתה]; it will be [יהיה] according to what will be explained[?] [כפי מה שיתבאר] —

L8. — [Red ink display band: an ornamented rubricated line — see the QA note below for its make-up and its black display text, which I have not resolved and have not completed.]

L8 (cold read — SUPERSEDES the withholding recorded in L8 above, which is preserved verbatim). — Thus far, the First Gate [ע"כ שער הראשון] [?] [?] — [a section colophon, in black display text within the red rubricated band; two further short clusters follow to its left, the second carrying gershayim, both unread]

L9. — This is [זאת היא] the introductions[?] [הקדמות] [?] ... [?] from the figure[?] [מתמונה] [?] it recedes[?] [תרחק] and it draws near[?] [ותקרב] [?] ... of [של] —

L9 (cold read — the title of the SECOND work, supersedes the unresolved reading in L9 above, which is preserved verbatim). — This is [זאת היא] the Introduction to Mevo She'arim [מות מבוא שערים] [ר/ד] [הק] [?] ... [?] —

L10. — [a SHORT line: two words only, each carrying a mark above it; neither resolved — see the QA note] —

L11. — [Gold display word: אמר] — Said [?] the young/humble one[?] [הצעיר] [?] [a two-word personal name — reported by sorts in the QA note below and NOT completed] [?] ... [?] I wished[?] [רציתי] to compose[?] [לחבר] this[?] key[?] [מפתח זה] and to illuminate[?] [ולהאיר] —

L11 (cold read, CONFIRMED on the leaf — SUPERSEDES the withheld name in L11 above, which is preserved verbatim). — [Gilt display word: אמר] — Said [אמר] the humble one [עיר] [צ/ה] Chaim [חיים] Vital [ויטל] — FOUR sorts on this leaf, **ל-ט-י-ו**, settled at 7.8× and 15×; there is NO **א** between the third sort and the **ל**. The five-sort census **ויטאל** is superseded — see QA. Δ This is a claim about this leaf's spelling of the name, not about how the edition should style it in English] [?] ... [?] —

L12. — [?] ... [?] which I received[?] [שקיבלתי] [?] the man of God[?] [איש האלהים], the Rabbi[?] [הרב] [?] —

L13. — and gaon[?] [וגאון], lamp of Israel [נר ישראל], [an honorific-plus-name chain carrying two gershayim groups — reported by sorts in the QA note below and NOT completed], of blessed memory [זלה"ה] —

L14. — [?] ... as [כאשר] [?] ... [?] you will be able[?] [תוכל] [?] and to take[?] [ולקחת] —

F. 43R, LINES 14–25

L14. — from Etz Chaim[?] [מעץ החיים], as[?] [כאשר] [?] ... of the [של] the introductions[?] [הקדמות] [?] ... [?] the form[?] [תמונה] [?] of blessed memory[?] [זלה"ה] [?] —

L15. — the wonders[?] [נפלאות] [?] ... to testify[?] [לעדויות] [?] which they wrote[?] [שכתבו], which in every generation [שבכל דור ודור] —

L16. — we have heard[?] [שמענו]; and so today [וכן היום] He has bared[?] [וישלח לנו] the arm of[?] [זרוע] His holiness [קדשו], and He sent us [וישלח לנו] —

L17. — [?] ... of blessed memory[?] [ז"ל] in his generation[?] [בדורו] [?] ... and rabbi[?] [ורבי] [?] of blessed memory[?] [זלה"ה], and He will be glorified[?] [ותתאדר] —

L18. — [?] ... a city [עיר] great [הגדולה] to God[?] [לאלהים] of[?] [של חכמים] —

L19. — years[?] [שנים] before[?] [קודם] [?] ... the form[?] [תמונה] [?] of blessed memory[?] [זלה"ה]; and he [והוא] [?] —

L20. — [?] this [הזאת] [?] ... according to [כפי] [?] ... [?] —

L21. — [?] ... and also[?] [וגם] there [שם] [?] ... according to[?] [ע"פ] [?] —

L22. — [?] ... to the one who[?] [לאשר] in his hand[?] [בידו], because thus[?] [כי כן] [?] —

L23. — [?] ancient[?] [עתיקים] [?] ... for his garment[?] [ללבושו], and [ואת] [?] —

L24. — [?] the introductions[?] [הקדמות], true[?] [אמתיות] motions[?] [תנועות] [?] ... which they handed down to us[?] [שמסרו לנו] —

L25. — [read from row 4, where it stands clear] —

[Aramaic: עיר וקדיש[?] מן שמיא[?] נחית[?] — f. 43r L17. Four groups in Aramaic rather than Hebrew, standing inside a Hebrew sentence: עיר (three sorts), a five-sort group of the וקדיש shape, מן (two sorts, secure), a four- or five-sort group ending in א, and נחית (four sorts). Rendered in English only as far as the secure sorts carry it: "... from ..., he came down ...". I do not translate the two flagged groups, and I do not name the source of the phrase.]

F. 43R, LINES 25–27, AND THE LEAF FOOT

L25. — [?] ... to keep alive[?] [להחיות] [?] ... upon [על] [?] ... [?] were revealed[?] [נתגלו] [?] of blessed memory[?] [ז"ל] [?] —

L26. — [?] ... from him[?] [ממנו] [?] ... [?] like the men of our generation [בדעתם] [?] —

L27. — and they sought[?] [ויבקשו] [?] ... so that not [לבליתי] [?] ..., for there is a God[?] [כי יש אלהים] [?] ... and they said[?] [ויאמרו] [?] out of their zeal[?] [מקנאתם] [?] ... hear[?] [שמעו] —

f. 43v

F. 43V, LINES I–8

LI. — His greatness [גדולתו] and His wonders [ונפלאותיו] ... [?] in holiness[?] [בקדש] [?] ... the holy ones[?] [הקדשים] [?] —

L2. — [?] ... it/they [?] ... [?] and His wonders [ונפלאותיו], to the one whom[?] [לאשר] the eye has seen[?] [עין ראו], and not [ולא] [?] —

L3. — [?] ... [?] which was[?] [היתה] [?] number[?] [מספר] [?] ... the holy[?] [הקדוש], for[?] [כי] [?] —

L4. — [?] ... [?] and in all the earth [ובכל הארץ] [?] motions[?] [תנועות] [?] ... in the Talmud[?] [בתלמוד] [?] in motions[?] [בתנועות] [?] to set upon each and every thing[?] [לשים על כל דבר ודבר] —

L5. — [?] ... when there is no [כשאין] man [אדם] [?] ... who knows [יודע] in the work of[?] [במעשה] [?] ... [numeral: 7] [?] against[?] [כנגד] [numeral: 7] the days of the Work[?] [ימי המעשה], and afterward[?] [ואחר] —

L6. — how many aspects[?] [כמה פנים]; and Levanah [the Moon] [והלבנה] [?] ... [?] the day of Shabbos[?] [יום השבת], and he will be [והיה] one who knows [יודע] [?] the introductions[?] [הקדמות] —

L7. — [?] the judgment of[?] [משפט] her [אותה] [?] ... according to[?] [ע"פ] [?] ... the Work[?] [המעשה] of the Chariot[?] [מרכבה], and how many[?] [וכמה] [?] ... which every[?] [שבכל] morning[?] [בוקר] —

L8. — [?] ... and in the Work of Creation[?] [ובמעשה בראשית] and in the Work of[?] [ובמעשה] [?] ... [?] with one voice[?] [בקול אחד] [?] —

F. 43V, LINES 9–22

L9. — [?] we have heard[?] [שמענו] [?] ... from [מן] the ancients[?] [הקדמונים] [?] —

LI0. — [?] ... [?] like[?] [כמו] [a personal name of four or five sorts followed by a gershayim honorific — reported in the QA note below and NOT completed] [?] —

LI1. — [?] ... [an Aramaic-looking cluster, unresolved — see the QA note] [?] and so[?] [וכן] [?] —

LI2. — [?] ... [a second Aramaic-looking cluster, unresolved] [?] ... which was revealed[?] [שנתגלת] [?] —

LI3. — the Hebrews[?] [העברים] [?] ... [?] through ruach hakodesh[?] [רוח הקדש] [?] each and every thing [כל דבר ודבר] in its truth[?] [על אמתתו] —

LI4. — [?] ... and he[?] was one who knew [יודע] in the depth of[?] [בעמק] hidden things[?] [תעלומות]; there is [יש] [?] ... and the like [וכדומה] [?] —

LI5. — [?] he knew [יודע] every kind of wisdom [כל מיני חכמות] in precise detail[?] [בדקדוק] [?] ... [?] times[?] [פעמים] [?] and the speech of[?] [ושיחת] [?] —

LI6. — for indeed[?] [כי אכן] [?] ... like a flame of fire[?] [כשלהבת אש] [?] ... [?] he was [היה] one who knew [יודע] in all [בכל] —

L17. — the angels[?] [המלאכים], and he was [והיה] one who mentioned [מזכיר] [?] ... the [?] [ביום] [כ/ת] [הכ] [?] —

L18. — [?] ... and in every[?] [?] [ובכל] [?] ... and thus[?] [וכן] [?] all [כל] [?] —

L19. — they saw[?] [ראו], and not [ולא] a stranger[?] [זר]; moreover[?] he was [היה] one who knew [יודע] in natural science[?] [בחכמת הטבע] [?] —

L20. — [?] ... in the spheres[?] / in the transmigrations[?] [בגלגלים / בגלגולים] — not decided; see the QA note [?] ... [?] until [עד] that[?] [כי] [?] ... [?] the coming of our Messiah[?] [ביאת משיחנו], and for ever[?] [ולעולם] [?] —

L21. — [?] ... and in the depth[?] [ובעמק] [?] far off[?] [רחוק] [?] ... and he was [והיה] [?] —

L22. — [?] ... [?] which he thought[?] [שחשב] [?] ... and his study[?] was[?] [והיה תלמודו] [?] the verse[?] [הפסוק] of[?] [של] [?] —

F. 43V, LINES 22–28, AND THE LEAF FOOT

L22. — [?] his soul[?] [נשמתו], and he would call out[?] [והיה קורא] [?] in the standing[?] [במעלת] of the man [האדם], the merits[?] [הזכויות] [?] ... and the luminaries[?] [והמאורות] [?] ... and the transgressions[?] [והעבירות]; and he would give them [והיה נותן להם] —

L23. — a tikkun [תיקון] for each one [לכל אחד] according to [כפי] [?] his soul[?] [שנשמתו], and they would come[?] [והיו באים] [?] ... from the places[?] [ממקומות] [?] ... [?] the tikkun of their souls[?] [תיקון נשמתם] —

L24. — [?] and he would give them [היה נותן להם] yichudim[?] [יחודים] for each and every one [לכל א' וא'], according to[?] [כפי] [?] ... kavvanos[?] [כוונות] [?] particular[?] [מיוחדות] to him [לו] and to the root of[?] [ולשורש] his soul [נשמתו] which grasps[?] [האוחזת] —

L25. — [?] according to the root[?] [כשורש] of nefesh or ruach and neshamah [נפש או רוח ונשמה] of the righteous[?] [של הצדיקים] [?] ... and he was [והיה] one who knew [יודע], and he would recognize[?] [שיכיר] [?] with[?] [עם] [?] —

L26. — [?] ... a good spirit or an evil spirit[?] [רוח טוב או רוח רע], and he was [והיה] [?] ... those raised up[?] [מעולים] them[?] [אותם] [?] kavvanos [כוונות] [?] particular[?] [מיוחדות] to that one[?] [לאותו] —

L27. — the spirit [הרוח]; and he would rouse [והיה מעורר] the soul of the man [נשמת האדם] while he was still[?] [בעודו] alive [חי] [?] ... and he would bring it[?] [ומביאה] to himself[?] [אצלו] and speak[?] [ומדבר עמה] with it [עמה]; and he would also[?] [מוכיח] [והיה ג"כ] reprove[?] —

L28. — or the soul of the departed[?] [או נשמה של הנפטר] [?] ... [?] and he would speak with them [והיה מדבר עמהם] all he wished[?] [כל חפצו], and they would [והיו] disclose[?] [מגלים] —

f. 44r

[Margin: מד — the scribe's ink foliation, standing alone near the outer end of the running-header line]

F. 44R, LINES I–4

LI. — [?] ... words of Torah[?] [דברי תורה] [?] ... and it was[?] [והיה] [?] ... at the time of[?] [כשעת] [?] ... from [מן] [?] ... [?] —

L2. — [?] ... [?] and it will be[?] [ויהיה] more[?] [יותר] [?] ... [?] —

L3. — [?] ... in the heavens [בשמים] and in the earth[?] [ובארץ], and so too[?] [וכ"כ] [?] ... [?] —

L4. — [?] ... a name of five sorts ו ה י א ל י [?] ... [?] is revealed[?] [מתגלה] to him[?] [אליו], and this I knew[?] [וזה ידעתי] from him[?] [ממנו] [?] —

F. 44R, LINES 5–14

L5. — [?] ... [an honorific abbreviation with gershayim, not resolved] [?] it was not withheld[?] [לא נמנע] [?] ... from the truth of[?] [מאמתת] —

L6. — [?] ... [an honorific ז"ל] and there is revealed[?] [ומתגלה] [?] [the same five sorts ו ה י א ל י — see the QA note above] [an honorific ז"ל], and behold [והנה] [?] —

L7. — [?] ... as the composition of[?] [כחיבור] this[?] [זה]; all [כל] [?] ... [?] that they[?] [שהם] — [a line-filler stroke]

L8. — [?] ... intellect[?] [שכל] and [?] by way of[?] [ע'] the appearance of[?] [הופעת] [?] ... [?] —

L9. — [?] ... which I received[?] [שקיבלתי] from [?] [an honorific זלה"ה]; they will not suffice [לא יספיקו], all[?] [כל] — [a line-filler stroke]

L10. — [?] ... to the voice of[?] [לקול] [?] ... which I wrote [אשר כתבתי] to instruct them[?] [להורותם] —

L11. — [?] ... the sage[?] [החכם] from one[?] [מאחד] [?] ... [?] to write [לכתוב] and [?] —

L12. — [?] ... and derush[?] [ודרוש] — there are set in them[?] premises [הקדמות] and rules [וכללים] differing[?] one from another [שונים זה מזה] [?] —

L13. — [?] ... to conceal [להסתיר] the derushim [הדרושים] and to join together[?] [ולחבר] the premises [ההקדמות] —

L14. — [?] ... premise by premise[?] [הקדמה והקדמה] [?] in order [על סדר] [?] ... [an abbreviation of three sorts with gershayim, not resolved] because[?] [כי] —

F. 44R, LINES 15–24

L15. — Like this[?] [כזה] it will be easy [יהיה נקל] for the student [למעין] to find in them[?] [בהם למצאם] [?] ... [?] —

L16. — because there are[?] [לפי שיש] in the derushim [בדרושים] [?] ... many[?] [רבים] [?] which[?] [אשר] [?] —

L17. — [?] ... and to seal[?] [ולחתום] [?] ... I had no time [לא היה לי זמן] [?] ... [?] —

L18. — [?] ... in these derushim[?] [בדרושים אלה] [?] ... [?] —

L19. — [?] the sage knew[?] [ידע החכם] to go deep into them [להעמיק בהם] [?] ... [?] —

- L20. — [?] ... but only to add or to take away[?] [אלא להוסיף ולגרוע] [?] ...
[?] —
- L21. — [?] ... greater[?] [גדול] than doing[?] [מעשות] [?] ... as the premises
of[?] [בהקדמות] the enquirer[?] [החוקר], and as is mentioned[?] [זכנו] [?] —
- L22. — [?] ... the enquirer[?] [החוקר], a premise[?] [הקדמה] [?] —
- L23. — [?] ... lips of falsehood[?] [שפתי שקר] [?] ... [?] and so forth [וכו] —
- L24. — [?] ... neither to add nor to take away [שלא להוסיף ושלא לגרוע] [?] ...
... [?] —

F. 44R, LINES 25–27 — THE END OF THE TEXT

- L25. — As I heard [כאשר שמעתי] from the mouth of [מפי] [my teacher[?] —
the group and its honorific are reported in the QA note above and are not
completed] [?] ... [?] —
- L26. — [a short line, indented on both sides] to make it easier[?] [להקל] for
the student [על המעיין] in this composition[?] [בחיבור זה], and this[?] [וזה] [?]
... [?] [an honorific abbreviation of four sorts with gershayim] may His name
be blessed[?] [יתברך שמו] :
- L27. — [a short CENTRED line] [?] ... [a five- or six-sort closing word
flanked by colon marks — reported in the QA note below and NOT completed]
:

f. 44v

f. 44v carries no writing. Across the whole of the side there is no black ink,
no ruling, no column rules, no table, no heading, no marginal note and no
catchword. Everything visible on the leaf is show-through from f. 44r.