

Keli ha-Nehoshet

כלי הנחושת, "The Instrument of Brass"
— i.e., the Astrolabe

(c. 1148)

by R. Avraham ibn Ezra (אברהם בן מאיר אבן עזרא), ca.
1089–ca. 1161, born in Tudela (Muslim Spain), itinerant
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Translation by Scott Weisman



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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

The earliest surviving Hebrew treatise on the astrolabe, composed in the mid-twelfth century. It explains how to build the instrument and how to use it to tell time, determine latitude, locate the stars, and cast astrological judgments, and includes a table of bright stars with their celestial coordinates and Arabic-derived names. Remarkably, a surviving astrolabe bearing Hebrew markings that follow its instructions came to light in Verona in 2024 — the very city where the work was composed.

A NOTE ON THE TRANSLATION PROCESS

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

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

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

ACKNOWLEDGEMENTS

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Keli ha-Neḥoshet — The Instrument of Bronze

Title Page

Sefer Keli Neḥoshet — The Book of the Instrument of Bronze

By R. Avraham ben Ezra [Avraham ibn Ezra]

And it is:

An exposition of the workmanship of the astrolabe instrument [אצטרלוב, astrolabe] after the manner of Ptolemy [לבטלמיוס, li-Vatlamiyus = Ptolemy] — comprising the knowledge of the configuration of the heavens [תכונת השמים, astronomy] and the measurement of the earth by means of this instrument.

Brought to press for the first time

In the holy community of Königsberg [קעניגסבערג] in Prussia [פרייסען] — may it be built and established —

In the year ה'תר"ה [5605 AM = 1845 CE] from the creation of the world [לב"ע = li-vri'at olam].

[Online-archive imprint, modern Hebrew:] Copied and entered onto the internet — www.hebrewbooks.org — by Ḥayim, [in the year] תשס"ה [5768 AM = 2007/08 CE].

Kli nechosches

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Author's Dedicatory Poem

[The opening lines are a rhymed Hebrew poem in two stanzas. The first stanza rhymes on -nah; the second on -shet (an acrostic on the work's contents). The raised dots in the source divide each line into its two metrical hemistichs and are preserved here as ·.]

First stanza:

To You, O living God, I plead · grant help to the son of Ezra; his soul cries out in exile · upon Your mercy it leans; understanding has risen, kept hidden · revealed to Him, and his deeds are firmly set; may He give a wise man an understanding heart · for so is His name, and let us sing for joy.

[Rule]

Second stanza:

Blessed is the One who founds with utterance · He set [it] in place, and the wise are the sons of Sheth [שֵׁת, Seth]; by number He made them understand, and by measures · figures — circle and bow [עֵגוּל וְקֶשֶׁת]; and the likeness of the work of God [אֱלֹהִי] · He placed upon tablets and net [בְּלוּחוֹת וְרֶשֶׁת]; let a discerning heart come and learn · the book Keli Neḥoshet [the Instrument of Bronze].

[Rule]

Thus speaks Avraham the Sephardi [ספרדי], the author. [נאום אברהם ספרדי המחבר]

Word from the Publisher [דבר מאת המוציא לאור]

This book came into my hands in several copies, and among them shone forth before my eyes the copy found in the possession of the renowned scholar, our teacher and master, the distinguished Reb Shlomo Yoel of Drobno [מדרובנא], and likewise the copy found with the celebrated scholar Reb Wolf Heidenheim, of blessed memory (which is now among the treasures of the book-collection of my dear friend, well-known for his learning and great in understanding, the distinguished rabbinic gentleman, the esteemed and illustrious magnate Reb Yosef Michael — may his Rock protect and preserve him — son of Reb Chaim, of the city of Hamburg). I also examined the remaining copies of the body of this book, and I found that they all corresponded to a single pattern, without the least variation between them.

This copy that came into my hands is from the manuscript of the scribe Reb Shmuel — by his familiar name Reb Moshe Sofer of the city of Prague — which was completed in its copying on Wednesday [day 4], the 5th of Heshvan, in the year 393 [שצ"ג] of the sixth millennium of the Creation [ד"א — i.e. (5)393 AM = 1632/33 CE]. This copy was also brought into the manuscript collection of the Gaon, our teacher and master Reb [D.] Oppenheim, of blessed memory.

Since I know that the words of the great scholar, the Ra'ava [Rabbi Avraham ibn Ezra], are precious to all who know his name and have heard his fame, my heart prompted me to bring his book to the light of print — this book which until today still lies hidden and concealed among the manuscript treasures. Yet I did not feel moved to add a clarifying explanation upon the body of this composition, for the following reason: since it is known that nowadays a different path is followed by the astronomers of our age, according to the view of Copernicus [קאפערניקוס], I found no great usefulness in that. Only the bare text of the said great scholar do I now set before every discerning reader — and for the good, let my name be remembered.

[The signature/decorative letters at the foot:] ט ח ה צ — the Publisher [המוציא לאור]

Author's Introduction [הקדמת המחבר]

The author says: I do not have the power, in my own understanding, to translate one language into another except by a difficult route. Even in the Holy Tongue, we know of it only what is written in Scripture. Now this instrument, which is called by Ptolemy [the] aṣṭurlāb [astrolabe; אצטרלוב] — its names are many and varied among many languages, and I shall recall them as far as my ability reaches. And by means of the Name that instructs man with knowledge, my mouth shall give true guidance: I shall explain that instrument [the astrolabe] in thirty-six gates [שערים], and from God may my help come.

[The following two pages are the table of contents, listing the thirty-six gates by title.]

Gate One [השער הראשון]: On recalling the names of the instrument and the markings upon it.

Gate Two [השער השני]: On determining the altitude of the Sun by day and the altitude of the stars by night.

Gate Three [השער השלישי]: On determining the Sun's equalization [שווי] from the circles that are on the reverse [back face] [מן העגולות אשר באחורי היום] — the circles engraved on the instrument's reverse face; the word היום is printed on the page and is retained per zero-confabulation].

Gate Four [השער הרביעי]: On determining the true place of the Sun from the rete [מן הרשת].

Gate Five [השער החמישי]: On determining the [point] opposite the Sun [נוכח השמש] — the nadir / antipode of the Sun].

Gate Six [השער השישי]: On determining how many seasonal hours [שעות מעוותות, "crooked/unequal hours"] of the day have passed.

Gate Seven [השער השביעי]: On determining how many seasonal hours of the night have passed.

Gate Eight [השער השמיני]: On determining how many equal hours [שעות שוות] of the day have passed.

Gate Nine [השער התשיעי]: On determining how many hours of the night have passed.

Gate Ten [השער העשירי]: On determining the arc of the day or the arc of the night.

Gate Eleven [השער האחד עשר]: On determining the equal hours from the seasonal hours.

Gate Twelve [השער השנים עשר]: On determining the seasonal hours from the equal hours.

Gate Thirteen [השער השלוש עשר]: On determining the altitude of any degree you wish.

Gate Fourteen [השער הארבע עשר]: On determining the declination [נטיית] of any degree or any star you wish.

Gate Fifteen [השער החמש עשר]: On determining which degree or which star you wish will rise [is ascending], whether by day or by night.

Gate Sixteen [השער הששה עשר]: On determining the ascendant [המעלה הצומחת, the rising degree] and the descendant [והשוקעת, the setting degree], as it [the ascendant] is at the midheaven [בחצי השמים] and at the lower midheaven [באמצע ארץ].

Gate Seventeen [השער השבעה עשר]: On determining how many degrees each zodiacal sign rises in the equinoctial line [בקו השווי, the celestial equator].

Gate Eighteen [השער השמונה עשר]: On determining how many degrees each zodiacal sign rises in your own land [בארצך].

Gate Nineteen [השער התשע עשר]: On determining the two twilights [שני הנשפים, dawn and dusk].

Gate Twenty [השער העשרים]: On determining the equality of the shadows [שיווי הצללים].

Gate Twenty-One [השער האחד ועשרים]: On determining the altitude from the shadow [הגובה מן הצל].

Gate Twenty-Two [השער השנים ועשרים]: On determining how to take the latitude [רוחב] of any city.

Gate Twenty-Three [השער השלושה ועשרים]: On determining the place of the Moon and of the five wandering stars [חמש כוכבי נבוכה — the five planets].

Gate Twenty-Four [השער הארבעה ועשרים]: On determining whether a given star is retrograde [נזור] or direct [ישר].

Gate Twenty-Five [השער החמשה ועשרים]: On determining the occultation of the Moon and its reappearance [הסתתר הלבנה והראותה].

Gate Twenty-Six [השער הששה ועשרים]: On determining the place of the Moon's station [מחנה הלבנה].

Gate Twenty-Seven [השער השבעה ועשרים]: On determining the setting-up [erection / orientation] of the twelve houses of the heavens [שנים עשר בתי השמים — the astrological houses].

Gate Twenty-Eight [השער השמונה ועשרים]: On determining the place of the stars [planets] that belong to the seven swift aspects [לשבעה המבטים הרצים].

Gate Twenty-Nine [השער התשעה ועשרים]: On determining the great [fixed] stars that are on the sphere of the zodiac [בגלגל המזלות].

Gate Thirty [השער השלושים]: On determining with which degree a [given] star rises upon the earth [על הארץ].

Gate Thirty-One [השער האחד ושלושים]: On determining with which degree a [given] star sets [ישקע הכוכב].

Gate Thirty-Two [השער השנים ושלושים]: On determining the arc of day [קשת יום] and the arc of night [קשת לילה] of a star.

Gate Thirty-Three [השער השלושה ושלושים]: On determining the height of any tower or tree [כל מגדל ועץ].

Gate Thirty-Four [השער הארבע ושלושים]: On determining the height of any low object from where you stand [מקומתך], and on determining the depth of any deep object [עומק כל דבר עמוק].

Gate Thirty-Five [השער החמשה ושלושים]: On determining the entire making of the instrument [תקון כל מלאכת הכלי], whose breadth is not equal to the latitude of your own land [שאין רוחבו כרוחב ארצך].

Gate Thirty-Six [השער הששה ושלושים]: On determining the entire making of the instrument [תקון כל מלאכת הכלי] with an instrument that is incomplete [בלתי שלם — i.e. operating an instrument that lacks the needed graduation-marks/plates].

Gate One — On Recalling the Names of the Instrument, the Astro-labe, and the Markings upon It [השער הראשון מזכרון כלי האצטרלוב] והשמות הנופלים בו והרשמים אשר בו

I have called it the Instrument of Brass [כלי נחושת, keli neḥoshet], because [the craftsmen] generally make it of brass; but whoever wishes to make it of silver or of gold is free to do so. An instrument of brass has [these parts]: a ring [טבעת — the suspension ring], a throne [כרס — the kursī, the throne-piece], a mother [אם — the mater], a rete [רשת — the net/rete], a back-face [בריה — the back / its reverse], a rim [סרם — samekh-vav-mem; identification as "limb"/outer edge is uncertain], and a rider [רוכבו — the alidade / sighting-rule]. Now I shall set out each one of these in its place.

The beginning of the instrument is the ring [הטבעת], which is the [shackle/]chain [השלשלת] by which the instrument is hung up. It is proper that it be a ring within a ring [טבעת בתוך טבעת], so that the instrument will not be twisted out of true when you take it up for proper [sighting].

After this [comes] the throne [הכרס], which is fixed into the ring; it is a protrusion [בליטה] issuing from the mother [האם]. Each person makes it according to his own wish, in order to suspend the instrument.

After this [comes] the mother [האם], which is the round surface [השטח העגול] that is hollowed out [נחקק], within which lie all the plates [הלוחות]. Upon it [on its face] is the rete [הרשת]; and its reverse [ואחורי] is the back-face [הברית]. It is called "the mother" [האם, mater] because the remaining plates [הלוחות] are made in its likeness [as its offspring].

The mother [האם] has upon its face two diagonals [שני אלכסונים] — two perpendicular diameters / cross-lines. The one [diameter] is the higher one, from the head [top] of the ring [מראש הטבעת] — which is [where] the chain [השלשלת] by which it is hung extends downward [to the bottom of the instrument]. The second [diameter] cuts across [crosses] within the circle [העגול], from the left side of the man [מפאת שמאל האיש] who holds the instrument in his hand, toward his right [אל ימינו].

The head [end] of the diagonal [ראש האלכסון] that cuts across within the circle, [the end] which is at the left of the man [בשמאל האיש], is called "East" [מזרח] * and the one that is to the man's right is called "West" [מערב] *. And the diagonal [diameter] that descends from the head [top] of the ring [מראש הטבעת] down to the [lower] head — that being the one [end] that is with the ring [עם הטבעת] — is called "South" [דרום], and the one that is below [למטה] is called "North" [צפון] *.

Thus this circle is divided into four equal parts [quadrants; חלקים שווים]: the one part begins from the East and ends at the South; and this fourth [quadrant] is divided into ninety parts, which are called degrees [מעלות]. And it is the practice of the craftsmen [ומשפט האומנים] to place one large line [קו אחד גדול] every five degrees [כל ה' מעלות].

[Text continues into the next gate's matter on the following page.]

they write over the first one ה [5], after it י [10], after it ה [5]; and that ה — after it י [10], after it ה [5], the first — they write over it כה [25]; for it is ה [5], after it כ [20], after it י [10]. They number them in this way because of the practice [first introduced earlier]. * And in this way the engravers write the count of the degrees from one to ninety, until the end of the ninety. *

And this quadrant — through it you may take the sun's altitude, or the altitude of a star, by knowing the degree of its altitude. * A skilled person, master of measurement, can know from this quadrant the altitude of anything tall — of any tower or tree. *

The second quadrant begins at South and ends at North. It too is divided into ninety degrees [מעלות]. Its purpose is to know the depth of anything that lies low beneath your position, or the depth of any pit. *

The third quadrant begins at West and ends at North. It too is divided into ninety degrees. There, two further lines are set, each line dividing the degree into twelve parts; these parts are called etzba'ot [fingers / digits]. Over them one writes a line with the count of the fingers. * Its purpose is to know the

right [vertical] shadow and the inverse [horizontal] shadow. The line of the inverse shadow begins from the head of the chain [i.e., the suspension point] and runs down to the half of the quadrant that lies between North and West.

✱

The second line — the whole of it, the right shadow — begins from North and ends at half of the quadrant. ✱ And it will always come out that this half equals forty-five degrees [ארבעים וחמשה מעלות = 45]; for in this matter the count of the right shadow equals the count of the inverse shadow, and the inverse shadow corresponds to it [point for point], with no addition and no subtraction in any case, just as the sun's altitude reaches there. ✱

The fourth quadrant begins at West and ends at South. It too is divided into ninety degrees. There are craftsmen who place [yet more] circles there, to draw the chord [secant] from the arc — but most craftsmen do not place them, because they are not exact at a single stroke, only approximate. ✱ Yet in calculation a person can derive them precisely, so we will not discuss them. ✱

These three quadrants — the East-North, the West-North, and the West-South — were not divided into ninety degrees for [computational] need, as the East-South was; only the East-South was divided for the general purpose of finding the sun's parallel of altitude. And where one does not draw the circles of the sun's parallel of altitude, there is no need to divide them at all — only the East-South for [computational] need, to take [readings of] the degrees. ✱

Behind the mater [אם] there are circles [drawn] for [finding] the sun's highest parallel of altitude. ✱ Some of them are divided into degrees; this is the circle which is [the outermost] of the four quadrants I have mentioned. ✱ Below it, there is another circle; over it is written "twelve zodiacal signs" [שנים עשר מזלות], each sign of thirty degrees [בשלושים מעלות = 30]. ✱ Below that, [yet] another circle; over it are written the days that are the days of the solar year. ✱ Below that, [yet] another circle; over it is written [a division] for the days of the months of the nations [i.e., the civil/Gentile months]. ✱ If you wish to make [a circle] for [counting] the degrees, and for the days, the choice is yours: by the way of [the first] or by the way of [the second]. ✱

These circles serve to know the sun's parallel of altitude — and that is by the approximate way, not the exact one, ✱ because there is an excess upon the days of the year of a quarter-day [רביעית = ¼], and the quarter does not balance out exactly. ✱ Moreover, this quarter is not [exactly a quarter]: in every year a day falls short [in the reckoning], as I will explain in the Sefer ha-Toldot [Book of Generations / the Book of Natures]. ✱ Therefore there are craftsmen who do not make these circles at all. ✱

The face of the mater, when divided into degrees, is called ḥeik [bosom], and is also called ḥagorah [girdle]. ✱ There is great need of it. They begin from the head of the chain to count the degrees — five, then ten, [and so on] — toward the left side of the mater, until they complete [the count] at the head of the chain, opposite the right of the man [i.e., the figure]. ✱

Behind the mater there is a long instrument, in the form of a back-face [בריח], called the ma'tzor [the alidade / rule]: by passing it [along the scale], a person stops it to take [a reading of] the degrees. The ma'tzor too is a back-face. * The ma'tzor has, at its two ends, two plates of copper, and each one is pierced with two holes [נקבים — the sighting pinnules]. One [hole] — the larger — serves to know the sun's altitude. The other hole — the smaller one [beside] it — serves to know the altitude of a star, of the fixed stars or of the planets. * The sun's altitude too [is taken with the larger hole]: when its rays pass through it, [it is read off]; and the smaller serves when a [planet] obscures it [i.e., for the dimmer bodies]. *

Within the mater there are also plates [לוחות], which are likewise called the "daughters of the mater" [בנות האם]. * The plates differ [from one another] and are distinguished by a person's choice, man by man — whether they bear the count of the horizons [the climate-plates]. If they are [made] for the count of the horizons, three of them are made, and they write [the latitudes] upon them.

[The plate has writing] both in front and behind. Upon the face of the plate there are seven [climates]; and they write upon it "seven climates" [שבעה = 7]. * For the [region of] habitation is in the northern quarter, and it is divided into seven parts, called ofakim [horizons] or aklimim [climates]. *

Now I will speak of the [latitude] plate. Upon it there are three circles. * The first is the encompassing line [the limb], and it is the circle of the head of Capricorn [ראש גדי], for no zodiacal sign passes above it [i.e., reaches lower in altitude] — only the head of Capricorn, alone. It is called "the circle of the inverse [solstice]," [recte: the circle of the winter solstice — הפך הסתיו]. * The second circle is the circle of the head of Aries [ראש טלה] and Libra [מאזנים], for upon it pass [the points where the sun stands] for the heads of Aries and Libra; it is called "the circle of the equator" [משווה היום, lit. "equalizer of the day"]. * The third circle is the circle of the head of Cancer [ראש סרטן], for no zodiacal sign passes above it except [those] after the beginning of Cancer; it is called "the circle of the summer solstice" [הפך הקיצי]. *

So it is in the left-hand copper instrument [the southern-hemisphere plate]; only in the right-hand copper instrument the matter is reversed: the large [outer] circle is the circle of the head of Cancer, and the small one is the circle of the head of Capricorn; only the middle one is the same in both instruments. *

So too, there are two diagonals [אלכסונים] on the plate. * One diagonal cuts [the plate] from above — from the side of the chain — down to below; from above to the half of the plate it is called "the line of mid-heaven" [קו חצי השמים = the meridian], and from the half of the plate down to below it is called "the line of the rest of the earth" [recte: יתר הארץ — the residue/lower part of the earth], or "the line of the abyss" [קו התהום = the nadir line]. * The second diagonal cuts across through the middle of the plate; it is called "the line of equality" [קו השווה = the East–West line]. From it you can know how wide the plate is

— that is to say, how far the place is from the equal line upon which this plate was made. *

In this way you make [the determination]: count the bridges [גשרים] that lie beneath the equal line, and by their number — so [great is] the width of the plate. If the copper instrument is whole, count each bridge as one; * if it is a half-instrument, value each one upon two [על שנים]; * if it is a third-instrument, value each one upon three [על שלושה]; * if a fifth, upon five [על חמשה]; if a sixth, upon six [על ששה]; * if a ninth, upon nine [על תשעה]; and if a tenth, upon ten [על עשרה]. *

And you can also know the width of the plate from the circle of the head of Capricorn: count how many bridges it [the place] stands at, add twenty-four [כ"ד = 24] to it, and subtract from it [recte: see p. II], and the remainder is the width of the plate.

that is the width of the plate. * And you can also know the width of the plate from the circle of the head of Aries and Libra: count how many bridges it stands at, subtract from ninety, and the remainder is the width of the plate. * You can also know it from the circle of the head of Cancer: count how many bridges it stands at — that is the value standing [there] — subtract twenty-four [כ"ד = 24] from it, and subtract [it] from thirty [ל' = 30], and the remainder is the width of the plate. *

There are also bridges on the plate. In a whole copper instrument they complete ninety [תשעים = 90]; in a half, forty-five [ארבעים וחמשה = 45]; in a third, thirty [שלושים = 30]; in a fifth, eighteen [שמונה עשר = 18]; in a sixth, fifteen [חמשה עשר = 15]; in a ninth, ten [עשרה = 10]; and in a tenth, nine [תשעה = 9]; and the remaining parts are not standardized [לא יתקן]. *

These bridges: some of them are arcs, and some are circles; they lie in the upper half of the plate and descend beneath the equal line, according to the width of the plate. * Their beginning is from the left of the man [the figure] who is [drawn] in the instrument — and there "East" [מזרח] is written, which is the eastern edge — and they rise toward the right of the man, where "West" [מערב] is written, which is the western edge. * The first bridge of them is called the ofek [the horizon]. * It is the divider between what you have known and what you have not known: for what lies upon the [side of the] bridges is what is revealed to us of the celestial sphere, and the remainder is hidden from us. *

The practice of the craftsmen is to write upon [each] bridge the number of the parts of the instrument. * There are also craftsmen who draw, upon the bridges, lines that cut across the bridges; these are called "the lines of the zenith" [קווי הקדקד], and are also called al-samt [Arabic: السمات (al-samt, "the azimuth / direction")] — [they are the azimuth lines]. * But they are not truly exact, even in a whole copper instrument; they are only approximate, so we will not discuss them. *

There are also eleven lines on the plate, lying in the lower half of the plate; these are the twelve unequal hours [י"ב שעות = 12 hours], the crooked [seasonal]

hours, not the equal ones, as I will explain. * The sages of the Ishmaelites [the Arabs] are accustomed to place lines upon them: for the beginning of al-ṭāhir [Arabic: **الظهر** (al-zuhr, the noon prayer)] and for the end of al-ṭāhir; and also for the beginning of al-ʿaṣr [Arabic: **العصر** (al-ʿaṣr, the afternoon prayer)] and for the end of al-ʿaṣr. But we will not discuss them. *

And there is, upon the face of the plate, [the part] called the rete [רשת]; it is also called al-shabaka [Arabic: **الشبكة** (al-shabaka, "the net")], and it is [the part] in which are the zodiacal signs and the stars...

[Continuation of the description of the rete (al-shabaka), from Gate One.]

The rete has, upon it, a circle divided into two unequal parts. * The one part is the larger, and it is called the southern signs; * these are Libra, Scorpio, Sagittarius, Capricorn, Aquarius, Pisces. * The other is the smaller part, and it is called the northern signs; * these are Aries, Taurus, Gemini, Cancer, Leo, Virgo. * The form of this circle passes from the head of Aries to the head of Libra. There is no need for it except for the drawing [layout] of the circles. The two parts I have mentioned are the same on the brass instrument [astrolabe], * except that on the right-hand brass instrument the matter is reversed: the northern signs are the larger part and the southern the smaller part.

There are arcs cut out within, for [setting] the circles of the signs, and a smaller circle within them. * Their purpose is to place the stars upon this [rete], * and the rule of the craftsmen for placing the great stars — which are upon the sphere of the signs — is [to place them] upon those arcs, or upon a small circle, [putting] each star in the place fitting for it. * They place only the stars that are of the first magnitude [literally: "of the first glory"] or of the second magnitude. * The reason — both the first and the second — is that Ptolemy the King divided all the stars of [his] catalogue [literally: "of the year"] into six grades according to the measure of their bodies. * The brightest, fifteen in number, their grade is equal; these are of the first magnitude. The others, whose grade is equal to them, are of the second magnitude; after them the third grade; after them the fourth grade; after them the fifth grade; after them the sixth grade. *

No star is set above the first magnitude, nor above the second magnitude. * As to the stars that are within the [band of the] signs — since they are joined to the circle of the signs — Leo, for example, is joined to the circle of the signs; this is so because they have a single nature [literally: "they have one matter/property"]. * Others are near to the circle, and others are far from it according to their distance from the [circle of the] signs; and this distance is called roḥaḇ [latitude]. * The stars which are on the southern side are placed outside the circle of the signs, * and those which are on the northern side are placed within the circle of the signs. * Thus it is on the left-hand brass instrument. But on the right-hand brass instrument the matter is reversed: the northern stars are wiped [drawn off] to the circles, and the southern within them. *

There is no harm in this. * Nor is there need to mention the place of the brass instrument and its [riveted] rivets and pins — the makers of the instrument [know it], for each one makes it as he wishes.

Gate Two: On knowing the altitude of the sun by day and of the stars by night.

When you wish to know this, suspend the brass instrument [astrolabe] from your right hand. * If you are before midday, turn your face toward the east; and if you are after midday, turn your face toward the west. The general rule: set your face opposite the sun, and find the place where you find the alidade [ma'tzor]. * Lift the alidade [until you bring] the [back-]bar [briaḥ] [literally: turn it] so that the sun's light enters through the larger hole — which is upon the one end of the square plate, on the end of the alidade — and emerges through the left hole, the smaller, which is upon the second end of the alidade. * When you have done this, begin to count from the eastern end, and you will see the head of the alidade upon however many degrees it stands. * Thus is the altitude of the sun, if you are in the east, before midday; and so likewise in the west [after midday]. *

You can also do this by the smaller hole, if you have no larger one. * And if you wish to know the altitude of one star among the stars of the wheel of the signs or of the planets [literally: "the servants"], * suspend the brass instrument from your right hand, turn your face toward the star whose altitude [literally: "degree"] you wish to know, and close your eye. * Sink [aim] all the air [line of sight] toward the second eye [hole], lift, and turn the alidade until you see [literally: until the near one comes to you] the star through the smaller hole that is upon the one end of the square plate, [look] through the smaller hole which is upon the second end of the alidade * — until you see the star through the smaller hole which is upon the second end of the alidade. * When you have done this, look [to see] upon however many degrees the head of the alidade stands. * Begin to count from the eastern end. * Thus also [is] the altitude of the star [literally: "of the wheel"]. *

You can also know the altitude of the sun if you know its place on the wheel [zodiac], when it [the sky] is overcast, by seeing the eye, if its illumination has not been bright [strong], because it [the light] has been hidden by passing clouds. * [So that] you may set it [the instrument] and know thereby the altitude of the star and know its altitude [degree].

Gate Three: On knowing the equation [difference] of the sun from the circles [the equinoctial / the position on the sphere].

When you wish to know this, know first which present month it is [reckoning] now between the days of the Christians [the civil/Julian calendar]. * Then [count] how many days into the month, and set the alidade upon the [proper] day of the month, and it [the alidade] will be able [to bring] its head upon the [zodiacal] sign. * The degree which is upon the sign is that in which the sun is. * You will arrive at knowing the day of the month, if you know the place of the sun, by setting the alidade upon the degree: the day will then show you * as the degree showed [you]. * Even if you have no circles [tables], you can know the equinox [literally: "the equality"] of the sun. * For the sun enters the sign of Aries on the 14th day of March, and from the 14th of March give one degree for each day. * Then, near the end of each month, the sun enters the head of each sign. * This is not exact in fine detail, because at times the sun's course is longer, * and also [shorter], as I shall explain briefly [further on], and at length [literally: "in the section"] in the matter of the conjunctions [moladot].

Gate Four: On knowing the true place of the sun from the rete.

When you wish to know this, you need [an instrument] in which there shall be a rider [roḥeb] upon your alidade. * Take the altitude of the sun at midday, on the day whose [solar] place you wish to know. * Know, too, in which quarter of the year that day is which you seek, * and turn the circle of the signs [the rete], and the degree which you find upon the line of the meridian [literally: "the line of the ends of the heavens"] in that quarter — there, where the altitude of the sun matches [the altitude you measured] — is the place of the sun, truly. * The reason for [needing] the quarter is this: from the middle of March until the middle of June the sun is in the north, and is rising in it [increasing in altitude], and it is in the sign of Aries, Taurus, Gemini. * From the middle of June [מחלי יוניר] until the middle of September [מחלי שטאמבי] the sun is descending, [though still] in the north, and it is in the sign of Cancer, Leo, Virgo. * From the middle of September until the middle of December [מחלי דיקטנבר] the sun is descending and it is in the south, and it is in the sign of Libra, Scorpio, Sagittarius. * From the middle of December the sun ascends in the south until the middle of March [חלי מארסר], and it is in the sign of Capricorn, Aquarius, Pisces. *

Now there are two times in the year when the hours of the day are equal [the equinoxes], and the reason is that on their account the altitude of the sun at midday

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is equal [the same], with no difference between them in any place of its ascent, from the head of Capricorn to the head of Cancer, and one [arc] of its descent, from the head of Cancer to the head of Capricorn. * [There remains] then a difference of two days in the year: when [the sun] is at the head of Cancer — which is the end [northern limit] of the north, for there is no day in the year that reaches its altitude — and likewise when it is at the head of Capricorn, which is the end [southern limit] of the south, for there is no day reaching the altitude of [that] day — one of the days of the year [each]. * Thus, when you know the quarter of the year, the day opposite it [its counterpart] will not be confused for you.

Gate Five: On knowing the place of the nokhaḥ [the point opposite the sun].

When you wish to know this, count [literally: "strike/reckon"] from the place of the sun until the completion of six signs, which are 180 degrees, [taken] from the place [of the sun] on the sphere; and the place where 180 degrees are completed — there is the nokhaḥ [the diametrically opposite point]. * You will further arrive at knowing the nokhaḥ when you set the place of the sun upon the line of the equator [neqo ha-shaveh, the celestial equator / line of equality], and the degree which you find opposite it — there [literally: "opposite it"] is the equal nokhaḥ [the equated opposite point]. * The reason [it works] by the taking [reading off] of the nokhaḥ: the hour [time] is reckoned by the degrees of the sun. *

Gate Six: On knowing how many hours have passed of the day, of the crooked [unequal/seasonal] hours.

When you wish to know this, take the altitude of the sun at any time you wish, * take the place of the sun and set it upon the analogue [counterpart] of the altitude. * If the sun was [observed] at the time of taking an eastern altitude, set it [the sun's place] upon the eastern bridges [almucantars]. * If the sun was western at your taking [of] the altitude, set it upon the western bridges, and look at the nokhaḥ of the sun, [to see] upon how many hours [it falls], out of all the crooked [unequal] hours; and so many crooked [unequal] hours have passed. *

If the nokhaḥ is at the middle of the hour, and you wish to know how much there will be of the hour, set the nokhaḥ sign upon the head of Capricorn. * When you set the place of the sun upon the altitude — this is called the "middle marker" [siman emtza'i]. * Set the nokhaḥ of the sun upon the beginning of the hour, and mark [it] also there at the head of Capricorn — and this is called the "first marker" [siman rishon]. * Set the place of the sun also upon the end of the hour, and mark it also at the head of Capricorn — and this

[Gate Six continues from the previous folio.]

it will be called the marker of the latter [point]. * Observe how many degrees lie between the first marker and the latter, and observe how far the middle [point] stands from the first. Translate that distance into degrees [literally "join it to all the degrees"], and learn how much of an hour it amounts to [literally "how much a part of the hour is"]; these are called seasonal hours [שעות מעוותות, literally "crooked/distorted hours"]. For each day is divided into thirteen [י"ג] hours, and this varies [in length], changing in number with each day.

The Seventh Gate — Knowing how many seasonal hours of the night have elapsed.

Take the altitude of any of the planets [literally "the planets that mark," i.e. the marker-stars on the rete] of the rete, * and set it [the marker] upon its altitude in degrees. * If the planet was eastern at the moment its altitude was taken, set it at its altitude in the eastern degrees; * and if it was western, set it in the western degrees. Then examine the place of the sun: * how many hours' worth, of all the seasonal hours, [it stands from the horizon] — and so are the hours of the night that have elapsed, out of the seasonal hours [of the night]. *

The Eighth Gate — Knowing how many equal hours of the day or of [the night] have elapsed.

When you wish to know this, take the altitude of the sun at whatever time you wish [literally "take the altitude of the sun for each time you wish"], * and set the place of the sun upon its altitude in degrees. * If the sun was eastern at the moment of taking [the reading], set it in the eastern degrees; * and if it was western, set it in the western degrees. * When you have done this, make a marker at the head of Capricorn [ראש גדי] with the bridge [נתא = the index/rule of the bridge]. * Then turn the place of the sun until you set it [the bridge] at the eastern point of the first bridge [the first marked position], and mark there too, with the bridge, at the head of Capricorn. * Take what is between the two markers, namely the degrees, and divide them by 15 — 15 [ט"ו ט"ו]; * and what comes out in the division — so many are the equal hours of the day's degrees that have elapsed.

And if you wish to know how many hours remain until sunset, after you have set the place of the sun [as above]: * relying on the place of the sun, set the bridge at the western point of the first [position]; * and mark there too, with the bridge [נתא], at the head of Capricorn. * Take their degrees, [the degrees between the two markers], and divide them by 15 — 15 [ט"ו ט"ו]; * and what comes out in the division — so many hours remain until night. *

The Ninth Gate — Knowing how many equal hours of the night have elapsed.

When you wish to know this: * Take the altitude of one [א'] of the marking planets [the marker-stars], and set it upon its altitude in degrees. * If it was eastern at the moment of taking [the reading], set its altitude in the eastern degrees; * and if it was western, set it in the western degrees. * When you have set the planet upon its altitude, make a marker at the head of Capricorn with the bridge [נתא], and turn the place of the sun until you set it at the eastern point of the first bridge, and mark [there] — also with the bridge [נתא] — at the head of Capricorn. * Take the degrees between the two markers, * and divide them by 15 — 15 [ט"ו ט"ו]; * and what comes out in the division — so many hours of the night, of the equal hours, have elapsed. *

And if you wish to know how many equal hours remain until sunrise: after you have set the planet upon its altitude, * rely [on it]; make a marker, [set] the bridge [נתא] at the head of Capricorn; then [set] the place of the sun until you set it at the eastern point of the first bridge, and mark — also with the bridge [נתא] — at the head of Capricorn. * Take the degrees between the two markers, and divide them by 15 — 15 [ט"ו ט"ו]; * and what comes out in the division — so many hours remain of the night, until sunrise.

The Tenth Gate — Knowing how many equal hours there are in the day or in the night — this is called the arc of the day or the arc of the night [קשת הלילה / קשת היום].

When you wish to know this: * Set the place of the sun upon the first bridge at the eastern point, and mark at the head of Capricorn with the bridge [נתא]; * then [turn] the place of the sun until you set it at the first bridge at the eastern point, and mark — also with the bridge [נתא] — at the head of Capricorn. * Take the degrees between the two markers * — that is the arc of the day. * And what is left over from there [literally "what is missing from there"], namely the degrees, which are all the degrees of the sphere [כל מעלות הגלגל = 360] — that is the arc of the night. * And if you divide the arc of the day or the arc of the night by 15 — 15 [ט"ו ט"ו], you will find how many equal hours there are in the day or in the night. * And if you wish to extract the arc of the night before you have extracted the arc of the day [literally "the place of the arc of the day"]: * Set the place of the sun upon the first bridge at the eastern point, and mark at the head of Capricorn with the bridge [נתא], then [turn] the place of the sun until you set it at the eastern point of the first bridge, and mark — [also with the bridge נתא — at the head of Capricorn]. * Take the degrees between the two markers * — that is the arc of the night. * And what is left over from there, namely the degrees [literally "the degrees that remain"] — that is the arc of the day. *

The Eleventh Gate — Knowing the equal hours from the seasonal [hours], in the day or in the night.

When you wish to know this: * Determine the place [of the sun] for that day [literally "the place of the day"], and set the altitude of the sun [נוכה = its altitude] upon the first bridge at the western point if it is day; * and mark at the head of Capricorn with the bridge [נתא]. * Then [turn] the altitude of the sun until [you advance] by the count of the seasonal hour whose conversion you wished, * and mark — also with the bridge [נתא] — at the head of Capricorn. * Take the degrees that lie between the two markers, and divide them by 15 — 15 [ט"ו ט"ו]; * and what comes out in the division — those are the equal hours. * And if you wished to know this for the night: * perform this same operation with the degrees at which the sun is not [the degrees opposite the sun, i.e. the nokhah]. *

The Twelfth Gate — Knowing the seasonal hours from the equal [hours].

Determine the place of the sun for that day, and set the sun's altitude upon the first bridge at the western point, and mark at the head of Capricorn with the bridge [נתא]. * Then reckon up the equal hours that you wish to convert —

all of them — into degrees; * and reckon them as 15 [degrees] for 15 [ט"ו בט"ו], i.e. each hour as 15°, * until you reach the head of Capricorn at the number of those degrees. * Then you will see the sun's altitude [נוכה] — how many seasonal hours of all the seasonal hours [it stands]; * and so many seasonal hours have elapsed. * And if you wished to know this for the night, set the sun's altitude upon the first bridge at the western point [literally "the point of the west"], as I mentioned [earlier].

The Thirteenth Gate — Knowing the altitude of whatever degree you wish, of the circles of the constellations [מעגולות המזלות = the ecliptic circles].

When you wish to know this: * Determine which degree you wish, and set it upon the line of midday [קו חצי היום = the meridian]; * and see how many degrees it stands — and so will be the sun's altitude when it is at that degree. * The degree whose distance from the head of the reckoning [literally "from the head of the orientation"] is the inverse [opposite measure] of the distance of this degree [literally "as the inverse of the distance of the degree"] — that is the degree whose altitude equals the altitude of this degree.

The Fourteenth Gate — Knowing the declination [נטייה] of whatever degree you wish, or of whatever star you wish.

When you wish to know this: * Set the degree you wish upon the line of midday [meridian], * and see how much there is between that degree and between the degree at the head of Aries [ראש טלה] and Libra [מאזנים] — which is the celestial-equator circle [עגולת משוה היום, literally "the circle that equalizes the day," i.e. the celestial equator]; * that is the declination of that degree. * If it is in the northern constellations [המזלות הצפוניים], the declination is northern too; * and if it is in the southern constellations [המזלות הדרומיים], the declination is southern too. * And if you wish to know the declination of a star, set the star upon the line of mid-heaven [קו חצי שמים = the meridian]; * and see how far is the distance between the star and the celestial-equator circle — that is the declination of the star. * If the star's degrees [its altitude in degrees] are greater than the degrees of the celestial-equator circle, the declination is northern; * and if the star's degrees are fewer than the degrees of the celestial-equator circle, the declination is southern. *

The Fifteenth Gate — Knowing whether a degree of the constellations, or a star, that you wish, will rise in the day or in the night.

When you wish to know this: * Set the degree you wish, or the star you wish, upon the first bridge at the eastern point, * and examine the sun's altitude

[נמעלה השמש]: whether the horizon [האופק] rises in degrees [i.e. whether the [chosen] point is above the horizon] — then it is day. * And know how many hours it will be from this: double the nokhah [the point opposite] by the hour. * And if the sun's degrees fall below the horizon — then it is night; * and know how many hours it is from this: double the sun's degrees themselves by the hour. *

And so shall you do when you wish to know the setting — when whatever degree you wish, or whatever star you wish, will set: * then set that degree, or the star, upon the first bridge at the western point. * And so shall you do when you wish to know the time when [a point] will be at mid-heaven [אמצע השמים = the meridian], or below the earth [under the horizon]: that you set it upon the line of [mid-]heaven, * or on the other line [the lower meridian, literally "the line of the remainder of the earth" — i.e. the meridian below the horizon]. * And do, with respect to the degree, all that I mentioned above. *

The Sixteenth Gate — Knowing the [degree] that rises and that sets...

[Gate Sixteen heading appears at the foot of folio טז/19; its text continues in the next folio.]

The Sixteenth Gate — Knowing the [degree] that rises and that sets

and which will be the nadir of the heavens and the lowest point [of the earth] — both by day and by night. * When you have set the astrolabe to know this — how many degrees high the sun is — at any time you set it, and you place the position of the sun [on the rete], then: if the sun was on the eastern side, the place of the sun [against the rim is read off as so-many] degrees from the east; and if it was on the western side, the place of the sun is so-many degrees from the west. *

Look at the [particular] degree that begins at the first bridge [almucantar] from the head of the eastern horizon — that is the rising degree; and the degree that begins at the first bridge [almucantar] from the head of the western horizon — that is the setting degree. * The one that is found at the meridian-line of the heavens — that is the degree that is at the midheaven [upper culmination]; * and the one that is found at the meridian-line of the earth — that is the degree at the lower culmination [the nadir]. *

When you set the astrolabe to know this, both by night and by day, do as I have recounted in every respect, and you will [find] the rising degree, the culminating degree, and the setting degree. * As for the stars fixed [engraved] on the rete, in the [way you found the] places of the sun, you will know by means of them the [degree] rising and culminating in the heavens and at the lower culmination of the earth. *

The Seventeenth Gate — Knowing whether [the degree] is at the equinoctial point

When you set the astrolabe to know this: * if [the rising degree] is at the equinoctial point [the equator], and its marker is with the head of Aries or with the head of Libra, then it is at the equinoctial point. * The sign of [the rising degree] being at the equinoctial point [is]: the head of Capricorn at the lower culmination [נתא, the nadir]; * and the sign [of the setting] is the head of Capricorn together with the head of Aries. * The astrolabe supports [confirms] that there are between the two markers [signs] — and place [them] also [ושים ג"כ — "and place also"; ג"כ is the adverb gam ken, not a numeral]; and thus you will [proceed]. *

The Eighteenth Gate — Knowing the [degree] in your land at the equinoctial point

When you set the astrolabe to know this: if [the rising degree] is at the equinoctial point — and its sign is, with the head of Aries, that it rises at the eastern equinoctial line; and the sign, with the head of Capricorn, is the end of that sign [of] the first bridge [almucantar]. * See how many [degrees] are between the two signs; * and thus you will [proceed].

The Nineteenth Gate — Knowing the night-arc and the day-arc

When you set the astrolabe to know this: by knowing the [length] of the night * — and likewise the arc [literally "the silver," i.e. the upper/visible arc ?] is what the astrolabe shows you of the body of the sun by the astrolabe, to know how many [hours] * the night-arc [keseph] and the day-arc are, [reckoning by] the body of the sun. * And it [the astrolabe] shows you the place of the sun [against the rim] both by day and by night. * And it shows you [whether] the light of the sun is among the clouds — and you do not see how many [seasonal] hours [there have been]; this — * if you wish to know

the night-arc [keseph] of the day * — and the astrolabe shows you the light of the [sun ?] before the sun sets [literally "appears, while concealed"]; the body of the sun thus indicates [its position]. * It [the astrolabe] shows you the place of the sun [against] eight degrees [ח ?] [past] east, and shows you the place of the sun [at] so-many seasonal hours [reckoned] from all the [hours past] — * and if you see [need] to know the night-arc [keseph] of the night *, after the body of the sun has set [hidden], the astrolabe indicates [it] thus; the markers being toward the east, it [the astrolabe] shows you the place of the sun, eight degrees [ח ?] west, and shows you the place of the sun at so-many seasonal hours [reckoned] from all the [hours]; * and thus the meridian-line [stands], so that the body of the sun stands [at the line]. *

The Twentieth Gate — Knowing the two arcs [the magnitudes]

Know that the [degree] of magnitude — however much it is for everything, by way of the parallel [horizontal level] and by way of the straight [vertical] * — [is] for every matter, or [its] diminution-amount from it, [in] which [it] is the diminution-amount from it. The one that is more than the straight is called "exceeding"; * and the one that is more than [the standard] is called "the opposite." * When you set the astrolabe [you measure] the place of the sun at any time you set it. *

If the magnitude [is to be reckoned] for any matter as it is, without any addition: the height that is more than 45 [מ"ה] degrees — these are all the parallels [horizontal levels], by way of the straight; and look how much [the measure is]. So [run] the count of the parallels. * If the magnitude [is] less than 45 [מ"ה] degrees — these the parallels can ever-fall [reach] for the world, by way of the straight, and thus their [computation]. * The magnitude [is] more than 45 [מ"ה] degrees — these the parallels [reckon] by way of the opposite; and look at [how much]; * and thus [run] the parallels [reckoned] by way of the opposite. * Measure [with] the index [alidade], and it will show you how much [there is]; [to] know — the angle [zenith ?] of the building [structure] in degrees, [the parallels reckoned] by way [of the building]. * [Take] the angle of the building, by [its] degrees, and set the index [alidade] at

the height up to the angle [edge] of the building — [that is the] fourth-part [quadrant] of that [reckoning]. * The angle [zenith], and its sign [is] thus: the quadrant of that [reckoning]; from the first sign and the last; and know the first [sign] and its base — [run it] against all the distance [reckoned], so that the markers [signs] of the building [stand].

And the index [alidade], and its sign [is] thus: the quadrant of that [reckoning], from any distance [reckoned by way] of the opposite. * And if [you reckon] the whole building by the level [parallel], let the markers [signs] of the building be * — a sign [for] the angle [zenith ?], [the part] of the quadrant that is its eastern, southern [angle]; [set it] on the beginning of the building [structure]. * And the sign [is] thus: set the building toward the end [of] that [reckoning]; * and know how many degrees [there are]; * and know how much the eastern [marker] is distant from the [base], and thus the markers of the building [stand]

at the upper-end of the bow [the index]. He explains [it] in the form [shape] of this — that it is the bow [of the index]; and arrange [set] it * — when each matter is divided, [everything] by thirty [ל]. * This — if it is not done by precise calculation, [it] is well [enough]; for in the rising of the sun [its measure] *, or in [its] setting, there is no arrangement [exact value] for the opposite. * But when the sun rises [by] a few degrees, then the magnitude falls — [and] it changes in every land, and land by land [it differs]; and one must measure it [each] before he reaches its [proper] knowledge. *

The Twenty-First Gate — Knowing the [equinoctial] magnitude

Knowing the [equinoctial] magnitude — from before [computing] the equation, as you knew the [equinoctial] magnitude, and the astrolabe shows you, in order to know the [proper] magnitude. * Look at this height of the degree, [as] seen [on] the index [alidade] at the fourth-part [quadrant], [counting] how many degrees in all. * And thus the magnitude

The Twenty-Second Gate — Knowing the breadth [width] of any city

Know that the distance [length] is — by however much the place is distant to the side, toward the equinoctial point, when you set the astrolabe to know this. * If you were there [up to] day י"ד [14] of the month of March [מָרְס], * [take] the height of the sun for the instrument [keli], the day [thus] * — and the magnitude, the head of Aries rises, and turn [reverse] it, and it is called gunah [גונה — celestial position/aspect]; [it is] * the gunah [גונה — celestial position/aspect] of the equinoctial [point], also [gam ken / ג"כ — an adverb, not a numeral] — turn [reverse] it at that place. * And if you were there [up to] day י"ז [16]

[the month of March, by reckoning,] * the height of the sun for the half of that day, and it diminishes — that is the gunah [גונה — celestial position/aspect] of the equinoctial [point], also [gam ken / ג"כ — an adverb, not a numeral] [past] the place. * And if you were there [up to] day י"ז [17] of the month of December [דִּקְאֲנֹבֵרִי = December *], take the height [of the sun], and add upon it 24 degrees [כ"ד]; and that is the place. * The gunah [גונה] of the equator [point], also [gam ken / ג"כ — an adverb, not a numeral] — and the [remaining] breadth [width] of the place. *

For [the sun] descends [in declination ?]; its [maximum] declination is 24 degrees [כ"ד]; * and however much you remain [reckon for] the days of the year, [it does] not [exceed] these 4 [ד]; * [computing] the breadth [width] of the place. * Take the height of the sun

at the half of that day. * And know that thus [if] the declination is southern, you add upon the magnitude *; and if it is the magnitude [width], to a small fraction you diminish [it]. * The addition and the diminution — that is the gunah [גונה — position/aspect], the head of Aries rises *, the day [its] count [being] [?]. The gunah [גונה] of the equinoctial [point], also [gam ken / ג"כ — not a numeral] * — [so that] you reach the knowledge of the declination, as I have stated above. *

The sun [stands] at the meridian-line at the half of the day, and it shows the [degree ?] between upon it the place of the sun, between the [orbit ?] of the circle [galgal]. And thus know — if the declination [is] toward the [meridian ?] line, the magnitude, [as I have explained] *; you will be able to know — and thus the breadth [width] of the place, from

to the half of that day. * And know that thus the declination of the sun for that day *; and if the declination is southern, you add it upon the magnitude from the [proper] magnitude, and [there] comes out, after the addition and [the diminution] * and the equation, that [it] is the gunah [גינה], the [magnitude] being [as printed] *; and it is the [remaining] breadth [width] of the place, and you reach [its] knowledge of the declination, as I have stated [above *].

The sun [stands] at the meridian-line at the half of the day, and it shows you the place of the sun, between the circle [galgal] *; and thus you will be able to know the breadth [width] of the place from the stars that are near it, [reckoned] upon the instrument [keli]. If [you] recognize one of them, take the [height of] their height [גובה ?] *; [that] which it rises — what [the index] is able to rise [to], the [proper] magnitude that [is] there [ההוא]. And take also [ג"כ — gam ken, "also"] of its falling more [further] * — its [own measure] more, until [it reaches its] place, [so that] it is able to descend * [to] that falling, and [the result] is established between them, [the count] of the rising and the falling, and [find] the mean [average ?] — the half [of the difference *] from the sun, [for] it is more correct thus. *

The Twenty-Third Gate — Knowing the [position] of the moon, and knowing the place

[Knowing] the position of the fixed stars [the planted ones] * — when you set the astrolabe to know [their position], by way of [their] nearness [proximity] *. Take their height, and take also [ג"כ — gam ken, "also"] of the [fixed] stars [engraved], the rete, [and look at the matter ?], and it will be [that] this [is] at a [given] time *. The fixed star [הקיים, "the standing one"], in the likeness [proportion] of its height in degrees [reckoned against the rim ?] * — to take its height, look at its height in [so-many] degrees, [reckoned *]; [set] it in [so-many] degrees, the eastern ones; and [if] it was east at a [given] time [נעת] * [and] if it was [west *, set] it in [so-many] degrees, the western ones; and put [reckon] the degree [against the rim *], so that it is filled [marked off] — the diameter [of the disk] of the moon, [or set the planet ?] *; and beware lest [you mistake] the disk [fullness] of the moon, or the [star *]

[the planet/star,] its [proper] place *. [Then] the star [stands] toward the east, at the side of the east, [where] you [take with the astrolabe]...

[The text of the Twenty-Third Gate continues beyond this folio.]

on the rete according to the analogous degree, and take its altitude in the east [if it stands toward the east]. Set the rete to the analogous degree according to its altitude, and you will then know its place by reckoning against the rim. Thus you can determine the analogous degree by [knowing] its altitude. [?] Take its analogous degree, and set the analogous degree of the sun against [the corresponding point], and you will be able to know the place of the star against the rim, and you can know the analogous degree of the sun. [?] Do everything just as I have mentioned. * Take the analogous degree, and the place of the

star [?], and do all that I have recalled. The points that are opposite each other at one moment [stand opposite at another]. *

If the star is to the east, set the rete to its analogous degree, and guard it. [?] Take the analogous degree of one star — one of the known stars [?] — and according to what came after it by two or three nights [?] against the analogous degree, whose measurement you have preserved [?]. If it was in the east [previously], it will [now] be [?]; and now it is [?]; it will now be in the west. * And afterward, set [?] the proper one. And if it [the star] was running toward the side of the east, by the first analogy these are [?] straight; it [the star] was running toward the side of the west; the second analogy will be greater than the first [?] — this is the moon [or: mor — myrrh?]. [?]

The Twenty-Fourth Gate. [השער הארבעה ועשרים] * To know whether [a star] is direct [straight in its motion] [?]. By the rete, to know [?] [if you] take the analogous degree of one star, a known star, and after it has been [observed] two nights or three nights [?] by the analogy of the [its] altitude that has been preserved [?]: if it [was] in the east, it will [now] be there, and now it is [?]; it will now be in the west. * And afterward, set [the rete] [?]. And if it [the star] was running toward the side of the east, by the first analogy these are direct; it was running toward the side of the east [?]; the star [was] running toward the side of the west — the second analogy will be greater than the first; this is retrograde [mor / reversed motion] [?]. *

The Twenty-Fifth Gate. [השער החמשה ועשרים] * To know the hidden position of the moon and its visible appearance [?]. You will see [the moon] from the last of the night-watch before the sun rises, and from the height of the moon's appearance [?]. If it [the moon] is hidden [?] toward the sun [in close conjunction with it], be on guard not to confuse the moon's disk with [the sun's] [?] [Lacuna: column edge cropped]. Whether you see [the moon] hidden, [in which case] the place [is reckoned] [?]: from the east, with the head of Capricorn [ראש גדי = Gedi, the sign Capricorn], likewise [gam ken / ג"כ — an adverb, not a numeral], and do [?]; how many degrees [?].

[The text here is set in a numeral-and-coordinate prose mixing degrees of altitude/azimuth with the moon's visibility; many cell-fine values sit at the cropped column edge and read [?].] If [the moon] does not appear — call it [?] keshet ha-mar'eh [the "bow of appearance" — Ibn-Ezra's coined term for the arc of visibility] — and all this [is] established, for it is near to the head of Aries [ראש טלה] or near to the head [of another sign] [?]. [?] [It is] hidden, and it [the moon] is covered [?]; take the second [value] [of] the third [of?] ha-mar'eh [the appearance], and add to it [?]: that [arc] over the degrees [is] the meaning of the two markers [?].

If the appearance is southern [ha-mar'eh deromi — toward the south] [?], take the second [value], a third [of] the appearance, and subtract it from the keshet ha-mar'eh. [?] That appearance [is], then, the appearance of [the increment / ha-tosefet — the added arc] [?]; the keshet ha-mar'eh [is] twelve [ל"ב] degrees [?]. * If [the moon] does not appear at all [?], it does not show the moon at

all; this is the keshet ha-mar'eh [?] degrees. The moon does not appear at all [?]. By this the keshet ha-mar'eh [is computed] — that it is, for example, the keshet [?], and that it is covered [?] [in the case that] it is near to the head of Aries [ראש טלה] [?].

And if you wish to know whether the moon appears or not — and if it appears [?] in the evening, after the sun has set [?] — [find] the place of the moon by the first bridge [gesher — the almucantar arc] at the rising of the sun [?]; the sun has risen in the west [i.e. reckon for the western horizon], and mark [it] forever [permanently], just as I have mentioned. [?]

The Twenty-Sixth Gate. [השער הששה ועשרים] * To know the parts [ḥalakim] that the moon's orb [galgal] traverses, for [the standard reckoning is] thirty-eight [?] for an eclipse [?] [Lacuna: column edge cropped]. Know that the appearance [mishtaneḥ — the variable] [follows] the law of the moon according to [?] [whether] the moon is alone [by itself] [?]; what is [?] as I have written in the Sefer Mishpatim [Book of Judgments — Ibn-Ezra's astrological work] [?], and here [?]. [The reckoning of] the lunar mansions [ha-maḥanot] in the language of Kedar [Arabic] [?] — and behold, to every constellation [mazal] [belong] two mansions [maḥanot]. [?]

Beginning of the [lunar] mansions [תחילת המהנות]

[The mansion is called maḥaneḥ [encampment]. [?] What follows is a list of the twenty-eight lunar mansions (manazil al-qamar). Each entry gives, right to left: the ordinal (Hebrew letter), the Arabic mansion-name spelled out letter-by-letter and separated by interpuncts, "ve-targumo" / "targumo" ("and its [Hebrew] translation is..."), and a count or brightness of the stars composing it. The Arabic names are transcribed as the printed letters give them; the standard manzila identification follows in brackets where the spelling and the Hebrew gloss agree.]

The list reads right-to-left in the source; the table below preserves the logical order (ordinal → Arabic name → Hebrew translation → star description).

#	Arabic name (as printed)	Identifica- tion	Hebrew translation (targum)	Stars
א (1)	א ל נ ט ה (al-Naṭḥ)	[al-Naṭḥ / al-Sharaṭān]	ha-na'ar ("the youth"), for it is the Horn of Aries	3 stars
ב (2)	א ל ב ט ו (al-Buṭayn)	[al-Buṭayn]	beten ("belly"); they are 3, like [the first]	3 stars
ג (3)	א ל נ ד ר י א ה (al-N-D-R-Y-A-H)	[al-Thurayya — the Pleiades]	it is Kimah [Pleiades], and it is [...]	2 stars
ד (4)	א ל ד ב ר א ו (al-Dabarān)	[al-Dabarān — Aldebaran]	me-ha-aḥar ("from the latter"); and it is a red star, and upon it are stars	a red star, with stars over it
ה (5)	א ל מ י ס א ו (al-Mīsān)	[al-Mīsān / al-Haq'a] [?]	kaf ("palm"); they are 3 small stars between two bright	3 + small stars
ו (6)	א ל ת מ י (al-T-M-Y)	[al-Han'a] [?]	ha-shoket ("the trough"); one bright star	1 bright star

#	Arabic name (as printed)	Identifica- tion	Hebrew translation (targum)	Stars
ז (7)	אלדרסין (al-D-R-S-Y-N)	[al-Dhirā' — the Forearm]	ha-zero'ot ("the arms"); and they are two bright stars	2 bright stars
ח (8)	אלנתרה (al-Natra)	[al-Nathra]	pizur ("scatter / the manger"); 20 small stars (כ' כוכבים קטנים), and between them like a cloud	20 small stars + nebulosity
ט (9)	אלטרף (al-Ṭarf)	[al-Ṭarf — the Glance]	ayin ("eye"); they are 3 stars; "forever hidden" [le-olam ne'elam]	3 stars
י (10)	אלגבהה (al-Jabha)	[al-Jabha — the Forehead]	metzah ("forehead"); they are 4 stars	4 stars
יא (11)	אלכותאין (al-K-W-T-A-Y-N)	[al-Zubra] [?]	ha-shokayim ("the legs/thighs"); one star	1 star
יב (12)	אלעזר (al-'Azr)	[al-Ṣarfā] [?]	ha-tevah ("the slaughter"); they are 4 stars, the upper one bright	4 stars
יג (13)	אלסמאן (al-S-M-A-N)	[al-Simāk / al-'Awwā] [?]	adom ("red"); one great star	1 great star
יד (14)	אלכפאר (al-K-P-A-R)	[al-Ghafr] [?]	ha-mekhuseh ("the covered"); they are three small stars	3 small stars
טו (15)	אלזנבאן (al-Zanbān / al-Zubānā)	[al-Zubānā — the Claws]	tesher — parenthetical (תע"ד רשת) [?]; two bright stars	2 bright stars
טז (16)	אלמעליל (al-M-'-L-Y-L)	[al-Iklīl — the Crown]	atara ("crown"); five bright stars	5 bright stars
יז (17)	קלב (Qalb)	[Qalb — the Heart (Antares)]	lev ("heart"); they are three stars	3 stars
יח (18)	אלשולא (al-Shawla)	[al-Shawla — the Sting]	ha-zanav ("the tail"); they are eleven stars, and the two are bright	11 stars (2 brightest)
יט (19)	הנטימ (H-N-Ṭ-Y-M)	[al-Na'ā'im — the Ostriches]	ha-korot ("the beams"); they are nine stars, the ninth bright	9 stars
כ (20)	אלבלדא (al-Balda)	[al-Balda — the District]	keshet ("bow"), for it is like a bow; there is no star there, and it is covered (הוא כמו קשת ואין שם כוכב והוא מכוסה תרגומו קשת כי)	no star (covered)
כא (21)	אלדבה (al-D-B-H)	[Sa'd al-Dhābiḥ]	ha-shoham ("the onyx"); and they are three stars (והם שלשה כוכבים, השוהם)	3 stars
כב (22)	אלשער (al-Sh-'-R)	[Sa'd Bula'] [?]	ha-tov ("the good"); they are two hidden stars (הם שני כוכבים נעלמים, הטוב)	2 stars (hidden)
כג (23)	שעראלשער (Sh-'-R A-L-Sh-'-R)	[Sa'd al-Su'ūd]	tov ha-tovim ("the best of the good"); they are two stars, and the one is bright (והם שני כוכבים והאחד מאיר, טוב הטובים)	2 stars (1 bright)
כד (24)	אללכוכי (al-K-W-K-Y)	[Sa'd al-Akhbiya] [?]	ha-alamim ("the mute ones"); they are two stars (והם שני כוכבים, האלמים)	2 stars
כה (25)	אלבזכר (al-B-Z-K-R)	[al-Fargh al-Muqaddam] [?]	aḥor ("hinder"), for it is after the tent [aḥar ha-ohel]; they are four stars (והם ארבעה כוכבים, אחר כי הוא אחר האוהל)	4 stars

#	Arabic name (as printed)	Identifica- tion	Hebrew translation (targum)	Stars
כז (26)	א ל פ ר ג ל (al-P-R-G-L)	[al-Fargh al- Mu'akhkhar]	ha-deli ("the bucket"); they are two bright stars (והם שנים כוכבים מאירים, הדלי)	2 bright stars
כז (27) — ordinal doubled, as printed	א ל פ ר ג ל (al-P-R-G-L) [second occurrence]	[al-Fargh al- Mu'akhkhar (the latter)]	ha-deli ha-me'uḥar ("the latter bucket") [המאוחר]; they are two middle stars (אמצעים)	2 middle stars
כח (28)	ב ט ן ה ל ח ו ת (Baṭn al-Ḥūt)	[Baṭn al-Ḥūt — the Belly of the Fish]	beten ha-dagim ("the belly of the fishes"); ten stars (עשר כוכבים) from among the fish	10 stars

After the mansion list, the prose resumes:

and the mansion is beneath the moon. * Behold, then, [?] to know the mansion — that is, [the table] sets out for every constellation [mazal] [?]. And if you do not know the place of the moon [?] — [Lacuna: column edge] it is opposite; begin from the mansion that [?] for every mansion [there is] a day [?] [if] you wish to be precise. * Also [there is] a small mansion [maḥaneh katan] [?], and arrange [ve-yataken] [?] that it be [?] at the end of the mansion [be-sof ha-maḥaneh]. *

The Twenty-Seventh Gate. [השער השבעה ועשרים] * To know the position of the constellations [matzav ha-shamayim] [?] that are upon the reckoning [piyus] [?] [Lacuna: column edge]. Let it be [?] [continues into the next folio].

[The foliation continues; this page-opening covers folios כז–כח (24–26) per the printed folio marks; see the QA report. The square-type figure "2" at the foot of pp. 26 and 28 is a gathering/signature mark, not body text.]

the sphere is divided into 32 parts, called "sides of the heavens" [ruchot ha-shamayim]; and four of them are called yetedot [the cardinal "pegs"]. The eight that lie between them are called semuchot [the "adjacent" points] — for they are adjacent. *

When you wish to determine the twelve "houses" [the astrological houses], take the Sun's altitude at any time you choose, and set the position of the Sun [on the rete] according to its altitude in degrees. * And if the Sun stands in the eastern quarter [i.e. is rising], at the moment you take the altitude, set them [the degrees] in degrees toward the west. * And if you want to set up the houses by night, take the altitude of one of the known stars from among the [stars of the] rete, and set it according to its altitude, in the manner I described for the Sun. * Then observe: the degree that is rising is called the beginning of the first house — and it is the ascendant degree, and is named the yated [the cardinal point]. *

Likewise observe the degree you find upon the midday line [the meridian]: it is the beginning of the tenth house, and is named the upper yated [the upper cardinal point]. * Likewise observe the degree you find at the first western end [point]: it is the degree that is setting, and it is the beginning of the fourth house, and is named the lower yated [the lower cardinal point]. *

Now there is no doubt regarding the four yetedot, for there are decisive proofs for them; only in the ordering of the four [intermediate] houses that remain — the others — is there doubt and dispute among the scholars. The four remaining are the second, the third, the fifth, and the sixth. There is no need to mention what Ptolemy said and those who disagree with him — only by the true method. *

After you have set the position of the Sun according to its altitude — or the position of the star according to its altitude — observe the degree you find at the beginning of the eleventh hour [line]: it is the beginning of the second house. * Likewise observe the degree you find at the beginning of the ninth hour: it is the beginning of the third house. * Likewise observe the degree at the beginning of the fifth hour: it is the beginning of the fifth house. * Likewise observe the degree you find at the beginning of the third hour: it is the beginning of the sixth house. *

And here there is no doubt: for the eighth house is opposite the second, and the ninth house is opposite the third. * And we have already said that the tenth house is the yated...

the upper [yated], and it is opposite the fourth, which is the lower yated. * The first house is opposite the seventh. * The twelfth house is opposite the sixth. * And behold the setting-up of the twelve houses; it remains for you to correct their positions [adjust them by latitude], as I shall explain. *

Know that the upright [equal] house is thirty degrees [in extent]; but there is also a "large house" and a "small house." * Know that all this God will bring upon you [i.e. all this is by divine ordinance]: for when a star [planet] is in a large house, its power changes from what it would be — this is called the "house of breath/spirit" [the strong, advantaged house]. * And likewise, when it is in a small house, its power also changes, and this is called the "constricted house" [the weak house] — as I have explained in the Book of Judgments [Sefer ha-Mishpatim — Ibn Ezra's astrological work]. * And now I shall draw for you the figure of the houses.*)

The Twenty-Eighth Gate — on the knowledge of the aspects [mabbatim] that pertain to the seven planets.

To know the aspects: there is great dispute among the sages of Greece, and between the sages of India and Persia. They have books concerning them. * When you wish to know the aspects, determine the positions of the seven planets. *

Know: if the star [planet] was below the earth [horizon], its aspect is called "lower," and is named a right aspect [mabbat yemini]. And if it was above the earth, its aspect is called "upper," and is named a left aspect [mabbat semali]. * Now the star whose ascending degree is in the sixth [zodiacal degree counted from another point]: it is at the beginning of the third house. Do not be concerned [i.e. do not insist] that it be at the beginning of the second or the fourth house. And its aspect, which is in the third [house], is at the beginning of the fifth house. Do not be concerned that the house be the [house of the]

following sign — these are not the aspects [you should reckon]; these aspects are leftward. *

And the star that is in the eighth house: its aspect with the ascending [sign] is an opposing [diametrical] aspect [mabbat nokhah], and this is the upright aspect [mabbat ha-yashar] that...

in the aspects. * And the right aspect shelters the light [sokhekh la-or] at the beginning of the first house, which it regards with the five [degrees] — a sextile aspect [מבט ששית]; and it shelters the light at the beginning of the ninth house, regarding with the five [degrees] — a trine aspect [מבט שלישית]. * It is also disclosed that the aspects do not always hold a fixed placement in the house, great or small — only the operation of the aspect [matters], as I shall explain; and likewise the [other] aspects. *

And the aspects that the left ones regard together with the right ones: the left aspect is a trine aspect with the right sextile aspect; and it is a "sheltering" aspect [מבט סכה — the covering/conjunctional relation] with the right trine aspect; and the left aspect is a "sheltering" aspect with the right sextile; and it is a trine aspect with the right trine. * And all these aspects — perform them upon the houses, not upon the degrees; do not stretch [the reckoning] over a house great or small among the aspects — only make the aspects as I have set forth earlier. *

And you shall rely on the aspects in this procedure, in the far house or the near one; and all this is an easy way. * If the "sheltering" [body] was at the beginning of the house [...]; and if the sheltering of the light was in the left sextile aspect at the beginning of the hour — that is to say [ר"ל], it is the leader of the house [נוהל הבית]. * Or if the sheltering of the light was in the right aspect, striking the degree that is over the hour — that is to say, behold it is the leader of the house. * And likewise the rest of the left aspects, if they were in the middle of the house; *

or the aspects — the right aspect — by the power of the degree that leads the left house: in this too there is nothing [further] required. * And [the question arises] only if the "sheltering" [body] was not at the beginning of the house and not in the middle of the house: [then] make the aspects as I shall explain. *

And so the working: Know the degrees of the house in which the first star is, and the degrees of the house in which the second star is. * And if the houses are equal in their degrees, then behold, [the reckoning] is equal for them — for all the houses that are at the middle of the aspect-instrument [the instrument-of-aspects, keli ha-mabbat]...

* And if you need to enlarge the middle houses or to make them smaller, do them and make the aspect as it [actually] is. * And if the houses are not equal, take the surplus of the difference between the two of them and divide it in half; add it to the small house, and upon that reckoning the aspects will come out true; and make the aspect as it [actually] is. * And in the Book of Judgments I shall explain the powers of the aspects.

The Twenty-Ninth Gate — on the knowledge of the positions of the great [bright] stars that are upon the sphere of the constellations [the fixed stars].

Behold, I shall write for you their positions as they were in the year 4906 of the creation of the world [ד' אלפים וט' מאות וששה] $= 4000 + 900 + 6 = 4906$ AM; $4906 - 3760 = 1146$ CE]. * Know that every star moves from its place by one degree in every seventy years. * And so it moves, in every year, fifty-one seconds and twenty-six thirds [$51'' 26'''$ /yr — the forward annual precession rate]. *

Add that to the position of the star as it is written. And if you wish to know its position in time past, take for each year 21 [כ"א] seconds and twenty-six thirds [כ"ו שלישיות] $= 26'''$; the page prints כ"א (21"), not the forward 51" — transcribed as printed, an inherited discrepancy with the forward annual rate], and subtract them from the position of the star as it is written; then you will find its position. * And behold, I shall now write their positions for you. * And further, I shall give you a method to recognize them upon the sphere [the rete]. *

And I have already informed you that they place into the rete only stars of the first or the second magnitude [mikhbod = magnitude]. * Now the star that is of the first magnitude, I shall mention it and every star whose magnitude I do not mention — know that it is of the second magnitude. *

[Star-list table — Gate 29. This page begins the catalogue of bright fixed stars. Each entry: star name (spelled out letter-by-letter), transliterated Arabic name, zodiacal sign, ecliptic longitude (degrees, minutes), ecliptic latitude (degrees, minutes), magnitude, and hemisphere (north/south). Coordinates are Hebrew gematria, read glyph-by-glyph on the scan at high magnification.]

#	Star name (Ibn Ezra)	Arabic name (spelled)	Sign [mazal]	Longi- tude	Latitude	Mag- nitude	Hemi- sphere
1	א ל ד ב ר א עין שור השמאלי [the Left Eye of the Bull = Aldebaran]	א : ד ב ר א : אלג [al-Dabarān = Aldebaran]	שור [Tau- שבעה ועשרים מעלות חמישים דקים]	27° 50'	5° 10' [חמשה מעלות עשרה דקים]	First mag- nitude [מכבוד הראשון]	South- ern [דרומי]
2	רגל הכלב [the Foot of the Dog = Rigel]	ו א : א ל ג [al-Jawzā' — the Arabic name of Orion; here applied to Rigel][?]	תאומים [Gem- ארבעה מעלות חמישים ושמונה דקים]	4° 58'	31° 50' [ואחד מעלות חמישים דקים] [recte: 31° 50' — text reads "ואחד ... [thirty-one] degrees, fifty minutes"]][?]	[not stated → second mag- ni- tude]	South- ern [דרומי]

Footnote (Rashi-script, foot of folio כט):

[Gloss: *) "The figure of the houses is a separate plate [luah meyuḥad] at the end of the pamphlet [ba-sof ha-ḥoveret]."] — an editor's note (H. Edelman) indicating that the diagram of the astrological houses promised in the text is supplied as a separate plate bound at the end of the fascicle, not inline here.

Gate Twenty-Nine (continued) — The Catalogue of the Great Fixed Stars

[The bright-fixed-star catalogue, opened at the foot of folio 31, continues here as running prose: each star is given as one clause — Hebrew name → transliterated Arabic name → sign (mazal) → ecliptic longitude → ecliptic latitude → magnitude → hemisphere (northern/southern). Entries 1–2 (Aldebaran; the warrior's shoulder al-Jawzā') were recorded at the end of the prior folio. The numbering below continues from entry 3. The in-text * marks that divide the clauses are preserved as literal *.]

Reproduced as a table preserving the source field order. Coordinates are spelled out in Hebrew words on the page and given here in degrees/minutes within the named sign.

#	Hebrew descriptor	Arabic name (as printed) → identification	Sign (mazal)	Ecliptic longitude	Ecliptic latitude	Magnitude	Hemisphere
3	"The warrior, called נלחם (the one who fights)"	אלעי ק [al-'ayyūq → Capella]	Gemini (בתאומים) [as printed; Capella belongs to Auriga — see note a]	7° 58'	16° 30'	1st	southern
4	"The shoulder of the warrior" (שכם הגבור)	מנכבא לגיבאר [Mankib al-Jabbār → Betelgeuse / Orion's shoulder]	Gemini (תאומים)	28° 8'	40° 20'	— [magnitude not stated; see note b]	southern
5	"The shoulder of the warrior" (שכם הגבור)	שער יאלעבור [al-shi'rā al-'abūr → Sirius]	Cancer (סרטן)	20° 48'	34° 10'	1st	southern
6	"The hideous one, its eye" (הכער עינו)	שער יאלגמיצא [al-shi'rā al-ghumayṣā' → Procyon]	Cancer (סרטן)	4° 18'	16° 10'	1st	southern
7	"The heart of the Lion" (לב אריה)	קלבאלעסר [Qalb al-Asad → Regulus]	Leo (אריה)	17° 31'	16° 10'	1st	southern
8	"The tail of the Lion" (זנב אריה)	אלצרפא [al-Ṣarfa → Denebola]	Virgo (בתולה)	40° 38' [>30° within a sign — as printed]	11° 20'	1st	northern
9	"The warrior without a lance" (הגבור בלא רומח) *	אלקאלעזאל [al-Simāk al-A'zal → Spica]	Libra (מאזניים)	11° 48'	0° 40' [forty minutes; no degrees written]	1st	southern

#	Hebrew descriptor	Arabic name (as printed) → identification	Sign (mazal)	Ecliptic longitude	Ecliptic latitude	Magnitude	Hemisphere
10	"The warrior with a lance, the first" (הַיְּמִינִי רֹמַח הָרֵאשִׁון) *	והוא [unnamed Arabic — al-Simāk (הַיְּמִינִי) → Arcturus by sense; see note d]	Libra (מאזניים)	27° 2'	10° 31'	1st	north-ern
11	"The falling eagle" (הַנֶּשֶׁר הַנוֹפֵל)	ל נ ס ר א ל א ע ק ע [al-Nasr al-Wāqī' → Vega]	Capricorn (גדי)	56° 25' [degrees 56 confirmed; 25' ran off the strip edge — >30° within a sign as printed]	36° 10'	1st	north-ern

#	Hebrew descriptor	Arabic name (as printed) → identification	Sign (mazal)	Ecliptic longitude	Ecliptic latitude	Magnitude	Hemisphere
12	"The mouth of the Fish" (פִּי הַדָּג)	פ ו ם א ל ח ו ת [Fam al-Ḥūt → Fomalhaut]	Aquarius (דלי)	24° 10'	13° [thirteen degrees]	— [magnitude not stated]	north-ern
13	"The head of the Woman" (רֵאשׁ הָאִשָּׁה)	ר א ם א ל מ ר א ה [Ra's al-Mar'a → α Andromedae, Alpheratz]	Aries (שלה)	2° 38'	12° 8'	—	north-ern
14	"The head of Cancer" (רֵאשׁ סַרְטָן)	ר א ם א ל ג י ל [Ra's al-Jīl → Castor/Pollux region; see note f]	Taurus (שור)	44° 48' [>30° within a sign — as printed]	23°	—	north-ern
15	"He made the head of Cancer" (עֲשָׂא רֵאשׁ סַרְטָן) [the left] (חמאל ר א ם א ל ג י ל)	ח מ א ל ר א ם א ל ג י ל [Ḥimāl Ra's al-Jīl]	Taurus (שור)	20° 39' [twenty degrees, thirty-nine minutes]	30° [thirty degrees]	—	north-ern
16	"The left shoulder of the warrior" (שֶׁכֶם הַגִּבּוֹר הַשְּׂמָאלִי) *	מ נ ב כ א ל ג ב א ר א ל א ס ר [Mankib al-Jabbār al-Aysar → Bellatrix]	Gemini (תאומים)	5° 28'	17° 30'	—	south-ern
17	"סמך עצר תרסן" (the support, the elbow of the buckler)	מ מ ס ך א ל ע נ א ן [Mamsak al-'inān → Capella region / Auriga; see note h]	Gemini (תאומים)	17° 28' [seventeen degrees, twenty-eight minutes]	20° [twenty degrees]	—	north-ern
18	"The head of the foremost Twin" (רֵאשׁ הַתְּאוּם הַנִּקְדָּם)	ר א ם א ל ת א ו ם א ל מ ו ם ר [Ra's al-Taw'am al-Muqaddim → Castor]	Cancer (הסרטן)	11° 48'	30° 15'	—	north-ern

#	Hebrew descriptor	Arabic name (as printed) → identification	Sign (mazal)	Ecliptic longitude	Ecliptic latitude	Mag-ni-tude	Hemi-sphere
19	"The head of the latter Twin" (ראש התאום מאוחר)	ראם אלת אום ר ל מו ם ר [Ra's al-Taw'am al-Mu'akhkhar → Pollux]	Can- cer (סרטן)	25° 48'	30° 51' [thirty degrees, fifty-one minutes — corrected from the prior 51° 31']	—	— [hemi- sphere not printed]

#	Hebrew descriptor	Arabic name (as printed) → identification	Sign (mazal)	Eclip-tic lon-gi-tude	Ecliptic latitude	Mag-ni-tude	Hemi-sphere
20	"The radiant one on the neck of the Lion" (המאיר בצוואר האריה)	אל מארא לדיב ענקל [al-Mā'ir... 'unq...; see note j]	Leo (אריה)	17° 18'	8° 30'	—	north- ern
21	"The bridegroom that is on the neck of the Lion" (הארוס שהוא בצוואר האריה)	אלדנביענקלא לשעע [... 'unq al-...; see note k]	Leo (אריה)	30° 28'	20°	—	— [not printed]
22	"The heart of the Scorpion" (לב עקרב) [in Scorpio, בעקרב]	קלבאלעקראב [Qalb al-'Aqrab → Antares]	Scor- pio (עקרב)	26° 45'	3°	—	south- ern
23	"The knee of the Bow, on the left" (ברך הקשת משמאל)	קרקבאלדעםאליסר [Qarqab al-Da'm... ?; see note m]	Capri- corn (גדי)	28° 18'	18° 10'	—	north- ern
24	"The ankle of the Bow" (קרסול הקשת)	ארקובאלדאמי [Arqūb al-Dāmi... ?]	Capri- corn (גדי)	20° 3'	53° [large — as printed]	—	south- ern
25	"The flying Eagle" (הנשר המעופף)	אלנסראלטאור [al-Nasr al-Tā'ir → Altair]	Capri- corn (גדי)	18°	29°	—	north- ern
26	"The tail of the Hen" (זנב התרנגולת), also called "the prophet" (זנביא)	אלטזיגא [Ala Ṭ-z-y-g-a — printed letters; not securely identifiable, see note o]	Aquar- ius (דלי)	24° 18'	8°	1st	south- ern
27	"The heart of the Fish" (לב הדג)	קלבאלחות [Qalb al-Ḥūt; see note p]	Aries (טלה)	9°	26° 20'	—	north- ern
28	"The shoulder of the Horse" (שכם הסוס)	מנכבאלפרס [Mankib al-Faras → β Pegasi, Scheat]	Pisces (דגים)	17° 18'	31° 20'	—	north- ern
29	"The left foot of the Woman" (רגל האשה השמאלית)	רגלאלמראהאליסרי [Rijl al-Mar'a al-Yusrā]	Tau- rus (שור)	20°	28°	—	north- ern
30	"The ankle of the Twin" (קרסול התאום)	ערקובאלגטא [Arqūb al-...; see note q]	Gem- ini (בתאומים)	18° 48'	24°	—	north- ern

#	Hebrew descriptor	Arabic name (as printed) → identification	Sign (mazaḥ)	Ecliptic longitude	Ecliptic latitude	Mag- ni- tude	Hemi- sphere
31	"The point [that is] between the two points" (הנקודה משתי הנקודות)	[no Arabic name given]	Scor- pio (בעקרב)	28° 9' [twenty- eight degrees, nine minutes]	60° 40' [sixty degrees, forty minutes; see note r]	—	— [not stated]
32	"The latter [point]" (המאוחר)	[no Arabic name given]	Scor- pio (בעקרב)	7° 19' [seven degrees, nineteen minutes]	35° [thirty-five degrees]	—	—
33	"The head that has no strength in it" (ראש שאין בו כח)	رأس الكواكب [Ra's al-Qā'id; see note s]	Sagit- tar- ius (בקשת)	26° 38'	32°	—	north- ern
34	"The neck of the Horse" (צוואר הסוס)	[no Arabic name given]	Aquar- ius (דלי)	20° 21' [twenty degrees, twenty-one minutes]	40° 34' [forty degrees, thirty-four minutes — corrected from the prior 44° 34']	—	south- ern
35	"The end of the tail-star" (קצה זנב כוכב), called קיטום [Qit-ṭum]	קיטום [Qitūm — printed letters; see note u]	[sign not stated]	20° 25' [twenty degrees, twenty-five minutes]	22°	—	south- ern

CLOSING INSTRUCTION — FINDING A STAR'S POSITION WITH THE INSTRUMENT

When you wish to identify the precise position of a star, take the instrument — the astrolabe — and note how far its longitude lies from the meridian (the line that halves the heavens). Examine the degree-mark you find on the rete [al-shabaka], the position the star occupies on the meridian: that is, the star fixed in your astrolabe [be-aṣṭarlāb shelkha]. The degrees lying between the position of the star and the ecliptic circle [ʿagulat ha-mazalot] are the star's latitude [merḥaq].

If the degrees of the star are greater than the degrees of the rete, the star is southern; and if the degrees of the star are greater than the degrees of the rete [it is]... [the text here continues:] and that which is from the degrees of the rete is northern — this is what is called the latitude of the star.

When it lies upon the ecliptic of the celestial equator [meʿagulat mashveh ha-yom] [i.e. the equator], that is what is called the declination [neṭiyot] of the star, as I have taught you in Gate Fourteen.

And if you wish to identify one [particular] star, and you wish to know its place — and you already know its latitude as well — then take its altitude when it is at the meridian. This is, when you see it rising as far as it can rise no higher and begins to descend: it is then at the meridian. Take the altitude, and you will know the latitude [merḥaq]. If it is northern, subtract the latitude from the altitude; and if it is southern, add the latitude to the altitude. Then

the remainder, the one that is lacking, [revolve / reckon around] the ecliptic in that quarter, and you will reach knowledge [of its place]...

[The instruction continues beyond the foot of this folio.]

the fourth [quarter], at the position of the sun and the degree it occupies. Then look at the celestial circles: according to the value of the altitude, either subtract the surplus or add the deficiency, [reckoning] there at its place.

You can also learn the position of stars when they are joined with the servant-stars. By knowing the position of the servant-stars and the value of their accompaniment, you will know the position of the star joined with them.

By this method you will be able to identify stars even if you do not [already] recognize them. For when you take a star you believe to be the great one that appears to you, and take its altitude — when it is at mid-heaven — and set the rete accordingly: if the star reaches the same altitude that you imagined of it, then it is in truth that star. And if you recognize one other star, you will be able to identify the rest. Here is the method: take the altitude of the star you do recognize, and set the star you know to that altitude. If the star was eastern at the moment its altitude was taken, set it on the eastern bridge; and if it was western at the moment its altitude was taken, set it on the western bridge. Take the altitude of one of the visible stars among the great ones, and you will see — if you find the altitude of any star matching that altitude — that it is that star itself. But only provided that you take the two altitudes within a single hour, so that the altitude does not change.

Gate Thirty: On Knowing at What Degree the Star Will Rise upon the Earth

When you wish to know this, set the star you have on the rete at the first bridge, at the eastern edge of the [horizon at] west. The degree you find on the rete at the eastern edge — at that degree the star will rise.

Gate Thirty-One: On Knowing at What Degree the Star Will Set

Set the star you have on the rete at the first bridge, at the western edge. The degree you find on the rete at the western edge — there the star will set.

Gate Thirty-Two: On Knowing the Star's Day-Arc and Night-Arc

That is to say: the time of its appearance above the earth while the sun is hidden beneath it — meaning the night.

When you wish to know this, set the star you have on the rete at the first bridge at the eastern edge of the [horizon at] east, and mark with the head of Capricorn [the alidade], and turn the star on the rete to the western edge, and mark again with the head of Capricorn. See how much lies between the two

marks: that is the day-arc of the star. If you subtract this from all the degrees of the sphere, you will find its night-arc. And if you divide the day-arc and the night-arc by fifteen, you will find how many equal hours are in its day-arc and its night-arc. And if you wish to derive its night-arc before deriving its day-arc: set the star you have on the rete at the first bridge at the western edge, and mark; and set it likewise at the first bridge at the eastern edge, and mark. Whatever lies between the two marks is its night-arc; you will find its day-arc [by subtraction from the whole circle].

Gate Thirty-Three: On Knowing the Altitude of Every Tower or Tree

When you wish to know the altitude of any tall thing, set the alidade at forty-five degrees on the [shadow-]quadrant by which the altitude is to be measured. Approach and withdraw opposite that tower you wish to measure, and travel along the path of the two sights until you see its summit. Now, when you sight with one eye and see the top of the tower, measure from the standing-place of your foot up to the base of the tower; add to that the height of your own stature, which is [the distance] from your eye to the ground — that is the height of the tower.

But if you do not wish to measure [from your eye] to the ground, then, after seeing the top of the tower, set the alidade on the fourth [quadrant] — the eastern one, turned toward the [shadow-scale] — at forty-five degrees, and travel along the path of the sights. If you find that you must stand in one place and turn only your eyes, and the place that appears in your eyes — which you measure up to the base of the tower — that is its height.

But if you cannot withdraw and approach so [as to sight the summit at forty-five degrees], stand in one place; lower and tilt the alidade until you see the top of the tower; and observe at how many degrees the standing-place stands on the quadrant by which the altitude is taken. Mark it there in degrees, or at some other position on the instrument opposite the point of the alidade. Then lower the alidade on the fourth quadrant — the eastern one, turned [toward the scale] — stand in your place, lower and tilt the alidade until you see the base of the tower, [along] the path of the sights, with the alidade fixed in its place. And when you see the sun [for sighting], stand in your place, raise the alidade up to the mark you fixed on the quadrant by which the altitude is taken — opposite the point of the alidade in degrees, opposite the point of the alidade — and when you have raised it up to that mark, tilt [the instrument along] the path of the sights toward the place of the wall, and measure from there up to the base of the tower. Set it against the number of fingers [on the shadow-scale of the instrument]: if double the alidade [reading] on the fingers of the reversed shadow [umbra versa], subtract the fingers of the shadow from the breadth; and if double the alidade [reading] is on the fingers of the straight shadow [umbra recta], add. The number of fingers of the shadow upon the breadth — which is

between the standing-place of your foot and the base of the tower — after the addition or subtraction, that result is the altitude of the tower. And always add the height of your stature, [the distance] from your eye to the ground.

And if you cannot measure up to the base of the tower [to find] its height: stand in one place, travel along the path of the sights until you see the top of the tower, and mark with [the alidade] how many doubled fingers of the alidade [it reads], and mark the place where you stood. Go to another place, forward or backward, travel again a second time toward its top, and see how many doubled fingers of the alidade [it reads]; mark that place too where you stood. Measure the distance between the first standing-place and the second; take the difference of the fingers of the two [readings], and set that against the [doubled] fingers of the alidade. Whatever results is the altitude of the tower.

And if you wish to know the altitude of the tower without measuring at all: sight the top of the tower and see at how many degrees the standing-place stands on the quadrant by which the altitude is to be taken; mark it there in degrees, or at some other position on the instrument opposite the point of the alidade. Then lower the alidade on the fourth quadrant — the eastern one, turned [toward the scale] — and stand in your place; lower and tilt the alidade until you see its base; lower the alidade opposite another wall and approach it until you see the base of that wall along the path of the sights, with the alidade fixed in its place. When you see the sun, stand in your place and raise the alidade up to the mark you set on the quadrant by which the altitude is taken — opposite the point of the alidade — and when you have raised it up to that mark, [sight] along the path of the sights to the place of the wall, and the place that appears, mark it and measure from there up to the base, and so [you find] its altitude. There is no need to add the height of your own stature.

Gate Thirty-Four: On Knowing the Altitude of a Thing That Is Below Your Position, or the Depth of Anything

When you wish to know the altitude of any thing that is below your position, set the alidade on the fourth quadrant — the eastern one, turned [toward the scale] — and travel along the path of the sights; raise and lower the alidade until you see its top; and measure from the standing-place of your foot up to the base of that thing, and subtract it from the height of your stature: the remainder is the altitude of that thing.

And if you wish to know the depth from the roof-top down to below, set a mark on the ground. If you have a square of shadows on that quadrant, hang the instrument on your left; and if you have a square of shadows on that quadrant, hang it on your right, and travel until you see the mark you placed on the ground, and see at how many doubled fingers of the alidade [it reads], and mark the place where you stood. Go forward and backward, and travel a second time toward the mark, and see at how many doubled fingers of the alidade [it reads], and mark that place too where you stood. Measure the

distance between the first standing-place and the second, and set them against the fingers [of the scale]: whatever results from the ratio is the depth — except that you must subtract from it the height of your own stature.

And if you were upon the top of a column and could not go higher, and you wish to know its height: set a mark on the ground and hang the instrument on your right. If you have a square of shadows on the fourth — the eastern — quadrant [proceed thus]; and if you have no square of shadows, hang it on your left, and stand on top of the column, and travel along the path of the two sights. Lower and tilt the alidade until you see that mark you placed on the ground. And when you see the mark, see at how many doubled fingers of the alidade [it reads], and set another mark; lower and tilt the alidade again until you see that mark, and see likewise at how many doubled fingers of the alidade [it reads], and measure the distance...

[continuation of] Gate Thirty-Four — the distance is measured from the count of the doubled fingers of the alidade against the last point, and that is the height. Likewise, if you wish to suspend the instrument by its right hand [i.e. hold it upright], you may do so by the back face, since you have no shadow-square on the eastern quadrant of its back. *

You may also do the following, after you have seen the mark you wished to observe: look at how many degrees the alidade's head [pointer] reads, out of all the ninety degrees of that quadrant, and set the alidade upon those degrees that are on the western side, where the shadow-square is on that quadrant. Then the edge [tip] of the alidade's pointer will show you the fingers of the shadow. * In this way you can always carry out your work.

To measure the depth of a pit: stand at the rim of the pit and sight through the pinnules [the sighting holes] until you see the surface of the water in the further wall of the pit [reflected at the far edge]. Note at how many doubled fingers the alidade reads, measure the diagonal [slant distance to] the pit, and the ratio you find between the fingers — so will be the depth. *

To measure the width of a single river: stand at the bank of the river on one side and sight through the pinnules until you see the other side. Fix the alidade in position [leave it set], and go and stand at another spot. Sight through the pinnules in a straight line, and measure on foot [pace off] from where you are standing to the spot you have sighted — so [you obtain] the width of the river. *

The Thirty-Fifth Gate.

Everything I have mentioned among all the operations — you can do it all on a plate [tablet] whose latitude matches the latitude of your land. But if you do not have a plate for the latitude of your land, and you wish to perform one of the operations: take a plate whose latitude is less than that of your land and perform on it the operation you wish to do; and also take a plate whose latitude is greater than that of your land, and perform that same operation on it as well, and observe what difference there is between the two latitudes. Then learn

how far your own place is from the lesser plate, add a proportional amount to it [interpolate], and so will that operation come out for your land. *

Example. We wished to find the rising degree [the ascendant] at latitude 36 [ל"ו] degrees. You have a plate for latitude 33 [ל"ג] degrees, and you also have a plate for latitude 39 [ל"ט] degrees. The rising degree on the plate whose latitude is 33, when the head of Aries [ראש טלה / 0° Aries] ascended, was [some value]; and on the plate whose latitude is 39, it was [some other value]. We saw that the difference between the two latitudes was 6 [ו'] degrees [of latitude]. Therefore, for each degree of latitude, [there is] one degree of the [ascending] sign. * Our place is 3 [ג'] degrees distant [in latitude] from the lesser plate; so we take 3 degrees of the sign and add them to the ascendant [given by] the lesser plate — on which the head of Aries was rising — and the ascendant in our land will be 3 degrees [higher]. So too for all the rest of the operations.

Only — if you wished to find the place of the sun, you can learn it from one plate alone [whether it is for a latitude] less or greater [than yours]. This is: that you take a plate whose latitude is greater than that of your land, [subtract] the [extra] degrees that are between the [latitude of the] plate and your land from the altitude of the sun, and upon the remainder you derive the place of the sun. Or: take a plate whose latitude is less than that of your land, add the degrees that are between the [latitude of the] plate and your land onto the altitude of the sun, and upon the sum you derive the place of the sun. *

Example of this. We wished to find the place of the sun at latitude 36 [ל"ו], and we have a plate whose latitude is 33 [ל"ג], and the sun's altitude was forty [ארבעים] degrees. We added 3 [ג'] degrees onto it [$40 + 3 = 43$], rotated the reshet [rete / star-net], and the degree that we found on the meridian line [קו חצי שמים] at [altitude] 43 [מ"ג] — that is the place of the sun. And if our plate had a latitude of 39 [ל"ט], we would subtract three [שלושה] degrees from the sun's altitude, rotate the rete, and the degree that we found on the meridian line at [altitude] 37 [ל"ז] — there is the place of the sun. *

The Thirty-Sixth Gate.

In all that I have mentioned concerning the work of the instrument, I have spoken only of a complete instrument — one on which you find a graduation-mark [גשר] at every degree of altitude. But if your instrument is not complete, and you wish to perform one of the operations and you do not find a graduation-mark at the required altitude: set the degree you wish, [reckoned] from the [zodiac] circle or from the tooth [pointer-tip] of a star, upon the graduation-mark that lies just before it [the one passed], and mark it with the head of Capricorn [ראש גדי — i.e. with the "Beta" pointer/index]. Then set that same degree, or that same tooth of the star, upon the graduation-mark that comes next [the following mark], and likewise mark it with the head of Capricorn. You will then see [pages run on:]

how much there is between the two marks. Take a proportional value relative to the first altitude — for it [the interval] is [an arc of] a circle [קשת]. And here I will give you an example for each one [case]. *

If you wished to find the place of the sun by the sixth part [שישית — the alidade-quadrant of the instrument], and the sun's altitude was 45 [מ"ה] degrees, but you have no graduation-mark at 45 on the sixth-part [scale] — only at 43 and at 45 [מ"ג ומ"ה] — : we rotated the rete to [the mark] that we passed, and there were [there] 24 [כ"ד] degrees of the sign Libra [מאזנים / Libra]. We also rotated the rete to the graduation-mark that comes [next], and steadied it always with the head of Capricorn [the Beta index]. *

We saw that the distance between the two marks was 5 [ה'] degrees [the page reads $\eta = 5$: מעלות והיו ה' הסימנים שביין שני הסימנים והיו ה' מעלות]. And here we took half of them, for [each whole] degree of our altitude was [the span] that falls between [the marks at] 43 and 45 [מ"ג ומ"ה]. Now if the sign you wish [to read] is from the head of Capricorn until the end of Gemini [סוף תאומים... ראש גדי], add the half onto the first place, and you will find the place of the sun. But if the sign you wish [to read] is from the head of Cancer until [the end of Sagittarius] [ראש סרטן ע"ס — ad, "until"], subtract the [computed] arc [קשת] from the first place, and then you will find the place of the sun. *

And here we took 4 [ד'] degrees [as] the [interval] that was found on the first graduation-mark [גשר הא] — which were 24 [כ"ד] degrees of the sign Libra — and subtracted them upon the place of the sun. Thus the place of the sun is [the resulting] degree of the sign Libra. *

And if you wished [to find the place] by the graduation-mark, [reckoning] from the head of Capricorn through [an interval of] 4 [ד'] degrees with the Beta [index], then the degree you find on the meridian line — there [on] the circle is the place of the sun. And the [name of the] graduation-mark is [that] of 45 [מ"ה]. Mark it on the plate fixed [in place]. *

Likewise, if you wish to find the rising degree [the altitude of the ascendant], do it by this method.

Example for finding the rising degree. We wished to know the rising [ascending] degree by the sixth-part [scale], and the sun's altitude was 45 [מ"ה] degrees. Here we have no graduation-mark — we set the place of the sun at [the mark] 43 [מ"ג], and made a mark [סימן] with the Beta [index], and looked, too, for the ascendant — which is the head of Aquarius [ראש דלי]; the place of the sun is steadied at the mark of 45 [מ"ה], and we made another mark with the Beta. Between the two marks there were 5 [ה'] degrees; we took half of them. * And if the sun was in the east, add it [the half] onto the first altitude, and you will find the [true] altitude. But if the was in the west, subtract it from the first altitude, and you will find the true altitude. *

And here, [if] the sun was [reckoned] from the head of Aquarius [we proceeded] truly [as above]. We took the 4 [ד'] degrees, the [interval] that we found on the meridian as 43 [מ"ג] on the graduation-mark, [namely] the head of Aquarius [ראש דלי], and the sun's altitude is 4 [ד'] degrees of Aquarius. * And if you find the star [reckoning] from the head of Capricorn through [an interval of] 4 [ד'] degrees with the Beta, and the ascendant comes out [as] the head

of Aquarius — all this is true, and everything [comes out as] one [consistent], whichever you wish. *

And so [do] the rest of every operation of the instrument, if you have no graduation-mark for the required altitude.

All this that I have mentioned [is] easy on an instrument whose zodiac-circle is divided into 365 [לש"ה] degrees [recte: 360 (ש"ס)], as in the complete instrument. *

But if you have no complete instrument and you do not find a line [קו] for the required degree on the circle: take a thread [קו תמצא — a fine line/thread], mark it [its position] with the Beta, and likewise mark it. Take the [next] line that comes [passes], mark it likewise with the Beta, and take the [proportional] value required. *

And here I will give you an example. We wished to know the place of the sun, and here we rotated the rete onto the meridian line [קו חצי שמים] at the altitude [reading], and we did not find on the apodate [the amudat ha-galgal — the circle's graduated edge/diameter-scale] a line for [the exact altitude]; rather, the line before it was [for] six [ו'] degrees of the sign Aries [מזל טלה], and after it the line was [for] 12 [י"ב] degrees of the sign Aries. We made a mark with the head of Capricorn [the Beta index] just as [we did before], rotated the rete onto the altitude, and we will call this the "middle mark" [סימן אמצעי]. *

After this, mark on the meridian line the position of the [apodate of the] circle, [where] the line of the circle's apodate which we passed [lies] — we will make another mark, and we will call this the "first mark" [סימן ראשון]. * Again, mark on the meridian line the [next] line that comes, and likewise make another mark with the head of Capricorn [the Beta] — we will call this the "last mark" [סימן אחרון]. *

We saw that between the first mark and the last there were 6 [ו'] degrees. And the middle mark was distant from the first by 3 [ג'] degrees. * Now, you wished [to know] the whole interval, in order to take a fourth; [namely] the six degrees that are [the span] from line 6 to line 12 [מן קו ו' לקו י"ב] [equal] the apodate [amudat] of the circle, and they [count as] one [whole] degree and 30 [ל'] minutes [דקים]. We added them onto the line that is the lesser — [namely] line 6 [קו ו'], which is 6 [ו'] degrees of the sign Aries [מזל טלה] — and they are 7 [ז'] degrees and 30 [ל'] minutes; and there [that] is the place of the sun. *

And if you wish [to find] the rising degree [the ascendant], do it too by this method, and here I will give you an example. We wished to find the rising degree, and the sun's altitude was [continues].

degrees, and the place of the sun is 9 degrees in Libra. Now there is no line on it [the instrument] in the middle of the zodiac circle for 9 degrees in Libra — it has only a line for 6 degrees and a line for 12 degrees. So we set the 6-degree line to the altitude and made a mark, together with the head of Capricorn [ראש גדי, the Beta index], on the [rim]; and we made a mark on the degree that was then rising [the ascendant]. Then we set the 12-degree line

to the altitude and made a mark, together with the head of Capricorn, on the [rim]; and there were 5 degrees between the two marks.

Of these we took the amount we wanted — two degrees — and added them to the first rising point on which we had made a mark. What results from the sum is the rising degree [the ascendant]. And if you prefer: turn the head of Capricorn through 4 degrees and look at the rising point — that is the rising degree for that moment. Do the same for the rest of the instrument's operations, if you should have an incomplete instrument. But the complete instrument is the best of all instruments.

[Author's colophon:]

This book was completed in the year של"ג [Hebrew: ש300 + ל30 + ג3 = 333; i.e. (5)333 AM = 1572/73 CE], on the eve of the fourth day [Wednesday], the 5th of Cheshvan [ה' חשוון], in the [Torah] portion of Lech Lecha.

I am the scribe. The cluster of camphire [a poetic flourish, after Shir ha-Shirim 1:14]. Giver of fair words [cf. Bereishis 49:21]. I complete this book. To God, Creator of the world. So speaks Shmuel, son of the exalted master, the distinguished R. Moshe — scribe of the holy community of Prague.

Diagram. A square divided by its two diagonals and by the two lines joining the midpoints of opposite sides, producing twelve triangular cells (the standard twelve-house horoscope square). Each cell carries a single Hebrew letter serving as a house-number (א through יב). Reading the cells, the legible house-letters are:

- ט [tet = 9]: top-right zone
- ר"א [recte: א"ר? = house 11]: top-center zone [the cell prints resh-aleph א"ר; house 11 expects א"ר — transcribed as printed, with the lower figure's clean א"ר as the intended value]
- י"ב / רב [12]: left-upper [?]
- ו [vav = 6]: center-upper
- ה [he = 5]: right-upper
- ז [zayin = 7]: right-middle
- א [alef = 1]: center-left
- ד [dalet = 4]: center-lower
- ח [chet = 8]: left-lower
- ג [gimel = 3]: bottom-left
- ה' / ב [?]: bottom-center
- (one cell label not securely legible) [?]

The twelve single letters number the astrological houses around the chart; several are abraded and are flagged rather than reconstructed by sequence.

Diagram. A larger square containing an inner tilted (diamond) square, with the corner regions further subdivided — the twelve-house layout of the astrolabe face. Outer-edge margin labels (one per side):

- Top edge: נורה ב [?] — reads "norah bet"; possibly a side/quadrant label [?]
- Right edge: אורך כ"ל [?] — "length" + [?]

- Bottom edge: לדק ס"ל / צדק ס"ל [?] — bottom margin label, partly abraded [?]
- Left edge: כוכב ז [Kochav / "star 7"] [?]

Around the perimeter, each of the twelve houses is labeled with a house-number letter together with a zodiac sign or instrument term. The legible compound labels are:

- ט (house 9) — "בקשת" / כ"ל בקשת [Sagittarius, קשת] [?] (top)
- י"א (house 11) — ט' בדלי [9° in Aquarius, דלי]
- י"ב (house 12) — גדי [נ/ב] [in Capricorn, גדי; the leading נ/ב is borderline] [?]
- ח (house 8) — מקבת [?] (right upper)
- ז (house 7) — בקרבת [?] / "בקרבת" (right)
- ו (house 6) — בקרבת [?] (right lower)
- ה (house 5) — ס' בקריה [?] (bottom)
- ד (house 4) — ע' בקרטן [Cancer, סרטן] [?]
- ג (house 3) — כלי בתקונות [?] (bottom-left)
- ב (house 2) — [label not securely legible] [?]
- ז / ה (left lower) — חתועות [?]
- (left side) — מקפת / מקבת [?]

Center inner square (three stacked lines, square type): אנת / בכת / מחאם [?] — three short terms in the central panel, abraded and not securely legible [?].

[Source is a blank page.]

לוח הטעות — Table of Errata (Corrigenda)

[Source The errata table reads right-to-left in the source: leftmost printed column = folio (דף), then line, then the erroneous reading, then the corrected reading. Reproduced below in logical order. Each entry: page (folio) / line → printed (erroneous) — corrected.]

#	Folio	Locus / line	Printed (erroneous)	Corrected reading
(hdr)	דף	שורה [line]	שגיאה [error]	תקן [correction]
2	ד [4]	ג [50]	[blank/—]	ת"י
3	ו [6]	ו [6]	קטטה	[?] הטעה / השטה
4	ט [9]	כב [22]	ג	בו
5	ע [70]	ג [3]	כרבוכו	(ט→כ) כרבוטו
6	טו [15]	יד [14]	חסר מאחר תבת	[phrase partial — INCONCLUSIVE] תבת היום מלת מן...
7	[—]	יח [18]	[?] נגשרים / בגשמים	[?] נטרם → נגשרים
8	[—]	כה [25]	וסמך	וסימן
9	ץ / ר [?]	ז [7]	וסיין	וסימן
10	יח [18]	כג [23]	לוחה	[?] לוחה / לוחה

[Editorial note: the right-hand folio/line gematria column is non-monotonic (ד, ו, ט, ע, טו...) — read as printed, never sequence-filled. Rows 8–9 (the recurring printed errors וסימן / וסיין) are the most confident corrections; rows 1, 3, 5, 6, 7, 9–folio, 10 carry [?] where glyphs would not register. Field alignment in several rows is genuinely ambiguous in the print and is flagged rather than force-fit.]

[Editor's note following the table, square type:]

ז"ו בכ"מ נתחלף ציוני ר"ת אשר מהראוי לבוא באמצע ב' מלות בסוף מלה א'. וכן להיפך מה שירגיש כל רואה. ואין צורך הכרחי לציין אחריהם.

In many places the marking of an abbreviation [ר"ת = ראשי תיבות] that ought to have come in the middle of two words has been transposed to the end of one word — and the reverse as well — as any reader will notice. There is no real need to flag each such case.

[End of the treatise.]