# Roba' Yisrael (רובע ישראל, "The Quadrant of Israel"); Latin *Quadrans Novus* / *Quadrans Israelis*

*[The Quadrant of Israel (the "New Quadrant")]*

*(c. 1288 (composition; this is a later manuscript copy))*

by Jacob ben Machir ibn Tibbon — **Profatius Judaeus** (יעקב בן מכיר אבן תבון), c. 1236–c. 1305, Montpellier/Marseille

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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

Jacob ben Machir ibn Tibbon's treatise on the *quadrans novus* — the improved astronomical quadrant of his own invention — describing how the instrument is constructed and used for astronomical and time-keeping measurements. In sixteen chapters (*she'arim*), it includes a table of fixed stars used in laying out the instrument. One of the most influential medieval works on astronomical instruments, it passed into Latin and was cited by Renaissance astronomers. This is the witness in BnF Hébreu 1031 (ff. 131–147), a richly rubricated Hebrew astronomy anthology that also contains a Hebrew *De Sphaera*, Ibn Ezra's astronomical/astrological works, and al-Ahdab's *Keli Ḥemda*.

## A note on the translation process

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

*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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# Roba' Yisrael (The Quadrant of Israel) — Jacob ben Machir ibn Tibbon (Profatius)

[Librarian note: pencil foliation "191" in the upper outer margin.]

[The upper ~40% of the page is blank parchment; the text begins mid-page with a rubricated (red) opening word, marking a fresh incipit — the start of this treatise. No end-of-prior-work colophon is present on this page.]

[Red ink: **Amar** — "Said"] Jacob ben Machir ben Tibbon ha-Zarḥi: Since the science of astronomy cannot be perfected in its knowledge except by means of instruments that the sages devised — [instruments for measuring, and instruments] of various kinds [?] — and among them is the instrument called the **astrolabe**, by which one comes to know much [?] of [what pertains to] this science [?]. Yet the scholars who occupy themselves with it are few [?], and are found only at the far reaches of the earth; and with all this, [mastery of it does not come readily?] [?]. [Several words of this line remain abraded: [?].] The ancients set themselves to prepare it [?], and many strove to bring it to completion [?]... but they did not succeed [?]; and with all this it remains very difficult [?]... Therefore I made a small instrument [that supplies?] everything one needs from the astrolabe as a whole, while leaving aside what is not needed in it [?], and which is easy to work with [?] for every [purpose one requires?] [?]. And I called its name **Roba' Yisrael** (the Quadrant of Israel), and I divided it into sixteen gates, [each gate to set out its matter?] and to explain it fully [?].

## Table of contents — the sixteen Gates

[The remainder of the folio and the top half of the verso list the sixteen *she'arim* (Gates), each heading rubricated in alternating **blue** and **red** display script, followed by a brief black-ink description of its subject in small Sephardic semicursive. The actual text of the First Gate begins on the following folio (f.132r); these two pages are the preface and this contents list only. The gate-headings themselves are large and fully legible; the small black descriptions are recovered here at higher magnification, with residual `[?]` where genuinely abraded or where the description wraps ambiguously around the colored headers.]

- [Blue ink header: **The First Gate**] — on the construction of the instrument, in which the whole [of it] is comprised [?].

- [Red ink header: **The Second Gate**] — on knowing the [meridian] altitude of the sun and its declination [?], and the position of the sun [in the zodiac?] [?]... [?].
- [Blue ink header: **The Third Gate**] — on knowing the altitude of the sun in whatever horizon you wish, by means of the ratio of [?] [...], and on knowing the altitude of the stars by night and the hours of the day [?].
- [Red ink header: **The Fourth Gate**] — on knowing the [seasonal] hours and the times [...] [in the passage of?] the sphere, and on knowing the hour and the times of each degree [?].
- [Blue ink header: **The Fifth Gate**] — on knowing the arc of the longest day and the arc of the shortest day, and the arc of daylight for each and every degree of the sphere; and [on knowing the climes] for which the longest day is a whole day [?].
- [Red ink header: **The Sixth Gate**] — on knowing the [rising?] of the signs in the sphere, for each and every degree in every sign [?].
- [Blue ink header: **The Seventh Gate**] — on knowing the risings of the zodiacal signs in whatever horizon you wish, for all the [oblique?] horizons [?].
- [Red ink header: **The Eighth Gate**] — on knowing the ascendant (*ha-maʿalah ha-tzomaḥat*) and the degree culminating in mid-heaven at whatever [hour] you wish, and the [setting?] of the lesser stars [?].
- [Red ink header: **The Ninth Gate**] — on knowing the day-arc of a star and its night-arc, and the degree with which the star rises with it, and the degree with which it sets with it.
- [Blue ink header: **The Tenth Gate**] — on knowing the ascendant and the degree culminating in mid-heaven, [by night?] from the brightness (*nogah*) of a star — from whichever star you wish among the [visible / fixed?] stars [?].
- [Red ink header: **The Eleventh Gate**] — on knowing the right ascension (*ha-maʿalah ha-yesharah*) or the oblique ascension (*ha-maʿalah ha-notah*), from the brightness of a star or the [altitude?] of the sun [?].
- [Blue ink header: **The Twelfth Gate**] — on knowing [the right or the oblique ascension?] [?], from the brightness of a star or the altitude of the

sun [?] [...]. [The Eleventh- and Twelfth-Gate descriptions share the same "right vs. oblique ascension" vocabulary and their small-cursive clauses wrap around the rubricated headers; the exact division of clauses between them is not fully resolvable at this resolution — [?].]

- [Red ink header: **The Thirteenth Gate**] — on knowing the hour from the [arc?] of the sun and the arc of the meridian by day; and on knowing the ascendant and the degree culminating in mid-heaven by night from the brightness of a star and the arc of midnight; and on knowing the [hour?] of the night [?].
- [Blue ink header: **The Fourteenth Gate**] — on knowing the latitude of a locality or its longitude [?] [...] [the height of persons?] [...] [?]. [Several clauses of this description remain only partially legible: [?].]
- [Red ink header: **The Fifteenth Gate**] — on knowing [?] [...], and on knowing the measure of the height of any high thing or any low thing, and of all the [visible?] things [?].
- [Blue ink header: **The Sixteenth Gate**] — on the fashioning [and layout?] of the making of the instrument [?].

[The lower ~half of folio 131v is blank parchment. Faint bleed-through from the following folio's text shows at the top of the blank area and is not transcribed.]

# Roba' Yisrael — ff. 132r–132v

*Jacob ben Machir ben Tibbon ha-Zarḥi. BnF Hébreu 1031. Sephardic semicursive, single hand. Paragraph-initial rubric words alternate red and blue throughout; the Gate headings are likewise rubricated (First Gate in red, Second Gate in blue).*

[Ornamental crown drawn in gold/ochre penwork across the head of fol. 132r, above the opening rubric. Decorative header band, no labeled points.]

**[Red ink header: השער הראשון — The First Gate]** — On the explanation of the markings that are on this instrument.

The degrees that run around the rim of the instrument are the degrees of the celestial equator (מעלות השוה). They begin opposite [1?] and run up to 90 (צ), from right to left; and they run from the beginning [of the scale] to the end of the quadrant (הרביעית).

**[Blue ink: Further (עוד)]** — [the markings] from [90?] to [180?], running from the beginning of Cancer (סרטן) to the end of Virgo (בתולה[?]).

**[Red ink: Further (עוד)]** — [the markings] from [180?] to [270?], running from the beginning of Libra (מאזנים[?]) to the end of Sagittarius (קשת[?]). [Stage-5: only סרטן (Cancer) is confirmed glyph-by-glyph on the leaf; מאזנים/קשת are the expected-sequence continuation, not verified — flagged.]

**[Red ink: Further (עוד)]** — [the markings] from [270?] to [360?], running from the beginning of Capricorn (גדי[?]) to the end of Pisces (דגים[?]); and they lie close to one another, three by three, finely[?]. [Stage-5: גדי/דגים not verified glyph-by-glyph — expected-sequence, flagged.]

**[Blue ink: Further (עוד)]** — [these are] the [seasonal] hours (שעות): [some number of?] degrees [?], set [across?] the scale. They are divided by the divisions of the seasons (חלקי העתים) [drawn?] upon the sphere of [rectitude / the horizon?]; and that degree is [?] [?].

**[Red ink: Further (עוד)]** — [this is] the [?] that is upon it, [namely?] the beginning of [the ascent?]; and [?].

**[Blue ink: Further (עוד)]** — [this is] the [?] that is upon it, [namely?] the beginning of [?] — these being close together, and they are of one form, and it is the small arc (הקשת הקטן).

**[Red ink: Further (עוד)]** — [regarding] the [seasonal] hours: the degrees within the arc [?], from the fifth degree up to the degree of Cancer[?] (שעלת סרטן), and on it are six[?] of the small degrees, which run from the beginning [where it] rises to the end of the quadrant — three from right to left and three from left to right.

And the great[?] arc (הקשת הגדול[?]) is from the fifth degree up to degree [?], and on it are six[?] of the great degrees, which run from the beginning of the fifties[?] up to the end of Pisces (דגים), grouped three [by three] finely[?]. Here there are [markings running] from right to left and from left to right.

And the [?] that are among them, [running] from [?] up to the end of [?], are the [markings for the?] [?]; and [?] are set within them, so that you may know [?] [?].

[fol. 132r ends here; the lower half of the folio is blank parchment. The First-Gate enumeration of the graduated scales — the equator-degrees on the limb (1–90), the four zodiacal quadrant-arcs (Cancer→Virgo, Libra→Sagittarius, Capricorn→Pisces, with the spring quadrant implied), the seasonal-hour/arc lines "three by three," and the small and great arcs — is recovered in its structural

skeleton and sign-names; several interior numerals and a few procedural verbs remain ambiguous at this magnification and are flagged rather than reconstructed.]

[fol. 132v]

And likewise the pointer (המורה, the sighting-index) and the plummet-stone ( אבן העופרת).

**[Red ink: Further (עוד)]** — [regarding] their markings, the perforated [points]; and with them one takes [a reading] opposite every matter [that has been mentioned].

**[Blue ink: Further (עוד)]** — on the back of the instrument, which was made [to bear] the months and their [days?], and their years[?] and [?], divided[?]; and from [the reckoning of?] the moon and [?] the degrees[?] [?] you may know [?].

[By it you may know] the day the month falls due[?] for the present[?] [reckoning]; and [?] [?] the limit of their Passover (גבול פסחיהם).

**[Red ink: Further (עוד)]** — the line that goes out [straight through?] the center [of the instrument] and passes over the degrees[?].

**[Blue ink header: השער השני — The Second Gate]** — For the knowledge of the degree of the sun (מעלת השמש) among the degrees of your sign[?], and [?] the day of the month, or the knowledge of the days [of?] the course[?] — [that is,] the knowledge of the degree of the sun. And likewise:

In which mansion (מחנה) of the moon's [cycle] the sun will be — or was — and the knowledge of the cycle (המחזור) that lies within the wheel of the zodiac ( גלגל המזלות) made upon this instrument; and [we shall give?] the knowledge of the reckoning of the hours of day and night, according to the present month and their [?], in whichever month it may be. And it is written[?] in [?].

**[Red ink rubric]** — [?] finely[?] in its due time[?]; [?] the whole length of their course[?], [that is,] the degree of the sun. When [?] the length[?], likewise the [?] will indicate the sun — in which mansion (מחנה) it is, [among] the mansions of the moon.

**[Blue ink: And if you wish (ואם תרצה)]** — to know in which mansion it is: [reckon] the day the moon is [in] the mansion[?] — [counting] from the mansion in which it was together with the sun on the day of the molad (conjunction), by the number of days that have elapsed[?].

[?] the line of noon[?] of the molad; and in the place[?] where [?] falls, the reckoning[?] is the mansion in which the moon stands on that day.

**[Red ink: And these (ואם/והם)]** — the mansions are [reckoned] only by way of approximation, for the mansions are not equal; the moon, too, does not travel an equal distance every day.

**[Blue ink: And when (וכאשר)]** — you know the place of the sun, marked upon the [gate?] of that number[?] within the wheel of the zodiac made upon this instrument [?] [?].

And with it you take the reading up to [?] [?].

**[Red ink: And behold (והנה)]** — as [?] again upon the back of the instrument [?] [?], you shall know [?] [?] according to the day the present month begins[?]; and by [that?] you shall know [?] the limit of their Passover (גבול פסחיהם). And if there is no [?] [?], [?] the sun [?].

**[Blue ink: When you wish (כשתרצה)]** — to know on which day the present month enters: know the years[?] [?] [that are] joined together in this [?].

[Take?] the years[?], and subtract from the whole the [Jubilee?] nearest to that reckoning; the [nearer to it the] cycle[?] comes out. And what remains in your hand are the years of the solar cycle (מחזור חמה), which are 28 (כח) years — and twenty[?]-[nine?] — and it is the year in which it has fallen[?].

Seek it in the wheel of the cycle (עגולת המחזור), and take the sign that corresponds to the year — the one that is [beneath?] it, below it — and carry it out[?] onto the sign that is before [?].

[Foliation: "133" in pencil, top-left of the recto.]

## Second Gate (conclusion) — fol. 133r

the month you seek. If the conjunction (*ha-meḥubar*, the *molad*) was less than seven, that is the day on which the month enters; and if it is more than seven, subtract seven from it, and the remainder is the day on which that month enters.

[Red ink header: **וכן תעשה —** "And thus shall you do"] to know, for every month, [the day on which] their interval (*ha-hafsakah*) falls: it is on the day after it.

Know the days that you have in hand from their reckoning, and subtract from them the largest whole-multiple (*ha-kelal*) nearest to that reckoning — the one closest to it — namely the cycles of the moon (*maḥzorot ha-levanah*), which are

[numeral: ?] years; and it is the year in which winter (*ḥoref*) enters in the first year. Then find, in the year above it, opposite that number, [the entry] in that year — and that is the fixed day (*ha-yom ha-kavua*). If the day is Sunday (*yom rishon*), their arrangement[?] (*ha-hafsakah*, "interval") falls upon it; and if it does not fall on Sunday, [take] the [Sunday] that comes after that day.

[Recovery note: p.5 (133r), the calendar-reckoning run in the upper part of the page. Now largely recovered — *maḥzorot ha-levanah* ("cycles of the moon"), *ḥoref* ("winter," resolving the earlier "חורב/חורף" token), and *ha-yom ha-kavua* ("the fixed day") are secure. Only the cycle-length numeral (*…אשר הם [?] שנה…*) remains at the cursive floor — the surrounding text supports the Metonic 19-year value (י״ט) but the glyphs do not confirm it, so it is left `[numeral: ?]` rather than filled from expectation.]

[Red ink header: **השער השלישי — The Third Gate**] For knowing the altitude of the sun (*govah ha-shemesh*) on every day and at every hour, from whichever horizon you wish of the horizons; or for knowing the latitude of the city (*roḥav ha-ʿir*) by the altitude of the sun; and for knowing the stars by night; and for knowing the length of the day (*shiʿur ha-yom*).

[Blue ink: **כאשר תרצה —** "When you wish"] to know [the position of the star][?] at one of the extremities of the horizons, whenever you wish, at the hour you wish: know in which degrees (*ḥalakim*) the meridian line (*kav ha-nokhaḥ*) lies; and whatever results from the ascending degrees is the latitude of the horizons; and whatever results from the descending degrees is the declination (*nogah*) of the sun, as on that day, in latitude[?], at the midpoint of those horizons.

[Red ink header: **ואם תרצה —** "And if you wish"] to know the altitude of the sun at noon (*ba-ḥatzi ha-yom*): place the thread (*ha-ḥut*, the quadrant's plumb-line) upon the degree (*ha-maʿalah*) whose noon-altitude you wish to know, and set the index (*ha-moreh*) upon it; then move it until [it reaches] the degrees of the declination (*ḥalkei ha-nogah*); and whatever results from the remaining degrees, upon the [scale of] altitude, is the altitude of the sun for that degree at that noon.

[Recovery note: p.5 (133r), the thread-and-degree procedure. Instrument frame and operators now recovered: *ha-ḥut* ("the thread"), *ha-maʿalah* ("the degree"), *ha-moreh* ("the index/pointer" — the earlier "התורה" reading corrected to **המורה**, confirmed by *moreh ha-ḥalakim* "degree-indicator" on 133v), *ḥalkei ha-nogah* ("degrees of the declination"), *govah ha-shemesh*. A few connective operator-tokens remain uncertain.]

[Red ink header: **ואם תרצה** — "And if you wish" (second occurrence), a variant for an hour other than noon]: when the southern [degrees] rise[?] (*ke-she-taʿaleh ha-deromiyim*), place the thread upon the degree whose declination you wish to know for its noon, and set the index upon it until [you move] it to the degrees of the declination; and whatever you fall short[?], you will find [it] cleared[?] (*menukeh*) — as you wish. The remainder is the declination[?] of the sun for that degree.

[Blue ink: **או על דרך אחרת** — "Or by another way"]: place the index upon the degree you seek — the degree that is meridional (*nokhit*) — [and] set the thread upon the [mark of the] declination; then [see] by how much it rises between [the horizon and] the declination that you reach[?] there, and likewise that degree; and this is the declination (*nogah*) of the sun for that degree.

[Red ink header: **ואם תרצה** — "And if you wish"] to know the altitude of the horizon[?] (*govah ha-ofek*[?] — the rubric's object phrase runs on into fol. 133v).

## fol. 133v

in which one is situated, by reason of the sun's meridian-passage (*nokhaḥ ha-shemesh*). Take the altitude[?] of the sun at the noon that has passed, and know its [place] at that horizon in the degrees of [its] altitude[?]. Moreover, know the sun at noon — [in which sign][?] it is, and in how many degrees you find it. And if it was among the northern degrees (*ha-ḥalakim ha-tzefoniyim*), subtract the value of that degree — it will be [subtracted] from the declination (*nogah*) that you found at that noon; and if it was among the southern degrees (*ha-deromiyim*), add the value of that degree to the declination[?] that you took. And what results after the addition or the subtraction is the altitude of the sun that was at that noon; and the remainder is the latitude of the city in which one is situated (*roḥav ha-ʿir asher ḥanah bah*). Likewise, if the [declination of the] sun is not [known]… [dense sub-procedure; interior clauses at the cursive floor: … *ותרגן[?] הגובה על חלקי … היום… וכבר שערנו… הנוטה*…].

[Blue ink: **עוד** — "Furthermore"]: set the thread upon the sun's circle (*galgal ha-shemesh*)… [continuation at the cursive floor].

[Red ink header: **ואם תרצה** — "And if you wish"] to know how much is the altitude of a star of the stars in the heavens (*kokhav min ha-kokhavim ba-shamayim*): [when you] wish to determine (*laʿamod*) the star's declination[?], place upon it the degree-indicator (*moreh ha-ḥalakim*) and move it (*ha-ʿatkehu*) to the degrees of the declination (*ḥalkei ha-nogah*), or to the degrees of the equal[-

scale] (*ha-maʿalah ha-shavah*); and the length of the degrees is the measure[?]. Thus shall you do [by day][?]. And [if it is] among the remaining degrees of the declination, [then] what is added is the length of the altitude[?]; and if [it is] among the remaining [degrees], it is the southern declination (*ha-netiyah deromit*)… and whatever results is the declination (*nogah*) of that star. And if the declination is less [than that measure], the declination is toward the south (*le-tzad darom*); and if it is equal[?], then the star is [passing?]… its position[?] (*moẓavo*)… above the sun's circle in the declination[?]…

[Recovery note: p.6 (133v), the star-altitude / star-position procedure. Recovered frame and operators: *kokhav min ha-kokhavim* ("a star of the stars"), *moreh ha-ḥalakim* ("the degree-indicator"), *ḥalkei ha-nogah* ("degrees of the declination"), *ha-netiyah deromit* ("the southern declination" — an explicit inflection of *netiyah*, which fixes the *nogah* = declination gloss for this gate), *le-tzad darom/tzafon* ("toward the south/north"), *galgal ha-shemesh* ("the sun's circle"), *ha-kotev* ("the pole"), *ʿal ha-aretz* ("above the earth"), *ha-maʿalot ha-nokhiyot* ("the meridian degrees"). The branching operator-clauses that tie these together remain partly at the cursive floor and are flagged inline.]

far from the equal[-scale] (*ha-shaveh*)… on this fixed [scale] you find… and whatever it is, is the star's declination toward the north (*li-f'at tzafon*); and if this declination [exceeds it], it is toward the north side (*le-tzad tzafon*)… and the pole (*ha-kotev*) is inclined… when the star is outside [the path of] the sun[?]… it rises upon that horizon; this star [lies] at the pole of that horizon… equal from the side of the [one] day… when the star… the degrees… the heavens… as though the star [were]…; and if it is separated (*nivdal*), add to the altitude… the pole, according to its distance (*merḥako*)… and it is when the star is above the earth (*ʿal ha-aretz*)… the meridian degrees (*ha-maʿalot ha-nokhiyot*)… the degree at which the star is now found — and that degree is thus found…

[fol. 134r]

[Librarian note: pencil foliation in the top-left margin, "154" (modern foliation gives 134; the middle digit now reads more like 5, but disagreement stands — see anomalies).]

the heavens beneath the earth — then its opposite point (*nokhaḥ*) will stand in place of its altitude; and take [its measure?] like them, from the arc [?].

And if you observe the stars that never set, do all of this in the same way: set the pointer (*morah*) upon that star, and afterward take your reckoning — [place] the thread upon the meridian line (*qav ha-nokhaḥ*), and see upon which degree the

pointer falls among the degrees [of altitude]; take those parts, and so will be the figure of the altitude [?].

[The following stretch — a procedural repetition with the thread and the pointer applied to a star's altitude and its northern/southern position — remains only partly legible even at higher magnification: the technical vocabulary (the thread, the pointer, the degrees, north and south, the altitude) is clear, but the connective phrasing cannot be verified glyph-by-glyph.]

and there will be the reckoning of the altitude [?]; [set?] the thread upon the base [?], and so [reckon] the *nokhaḥ* of the altitude [?] that falls [?]... by the same count [?]. [Blue ink: וכן] Likewise: [reckon?] the degree [?]...

[of] the star [?]; place the thread upon the position of the star [?]. And if you wish, set the thread [to?] the degrees, [one to the north?] and the other [to the south?]... [in?] the southern [degrees]; and the degree [?] that is distant, which is [the position of?] the star... [in?] the north [?], the *nokhaḥ* of the altitude that falls [?]; and by the other degree the [remaining] stars are known [?]. And the star nearest to it [?]... its altitude [?]... — the first requires no reckoning [?], since these are not [set down?] in this whole [reckoning].

[Red ink: ואם תרצה] And if you wish to know the sun's declination (*nogah*) — this is the reckoning: reckon by your thread [?]; and there are several kinds of it, and [some?] rise above them, according to the length of the day [?].

⚠ PARTIALLY RECOVERED: p.1 (fol.134r) lines ~9–12 — the declination / day-length run. Recovered: the passage does concern the sun's declination (*nogah*) and its dependence on the length of the day; the opening rubric is now legible as ואם תרצה ("and if you wish"). Still [?]: the chained fractional quantities remain below glyph resolution; none committed.

[Red ink: ואם תרצה] And if you wish, to know [the declination?]... [set?] the thread upon the degrees of altitude [?].

[Blue ink: עוד] Further: [you will know?]... [?].

[fol. 134v]

approximation (*kiruv*). [Red ink: וזה] And this [is a matter of full knowledge?] that comes by way of estimation (*derekh ha-hashaʿarah*) and demonstration (*mofet*) — not so with approximation. In general, the sun's declination (*nogah*) is small, since [the day?] is divided into equal parts [?].

At midday there are equal parts to the hour, and [likewise?] their counterparts, according to the measure [?]... but from the day [?]. And there are several kinds of shortfall in the altitudes reckoned upon them.

Estimate according to what has elapsed of the hour, from the parts [and] the degrees of altitude; in it you have your approximation — unless it be a day on which the sun rose [only] 3 [ג — ?] degrees. The greater part of the approximation-error falls in the fifth hour, and in the sixth, the seventh, and the eighth, because the sun's motion is [swift?] as it was at first — in the fifth and the sixth — for it is faster than the reckoning; [Blue ink: חדוש — a refinement.]...and the last part of the hours [?].

Its reason: as against [the swiftness?] of what elapsed at the first, [the parts?] are received, and every hour [?]... at the pole (*qoteb*) the day is like [a fraction — a fifth?] of an hour; and its length [?], the day is like a third [שלישית — ?] of an hour.

⚠ CORRECTED (was flagged "12 hours vs. 1 at the pole"): the higher-magnification reading does **not** support "twelve hours" against "one." The passage compares the day, at the pole (*qoteb*), to small **fractions of an hour** (a fifth — *ḥamishit* — a third, a seventh recur across these lines). The prior 12/1 hypothesis is retired. The exact fraction-words are read only partly (חמישית is fairly clear; the others sit at the ordinal-word floor) and are flagged, not committed. No boundary values invented.

[In general?] the truth of the matter is this: at the pole the day is like [a fraction of?] an hour [?];... the day is like a fifth [חמישית] of an hour. And [some?] parts fall [short?]... [that?] is above [?]. And likewise, what obtains at the pole — the day being [a seventh?] of an hour [?]. [Blue ink: ואולם] Yet the parts [grow] larger [?]; and all that gathers toward the *shivvuy* (the point of equality / equinox) — the parts diminish; and all that separates [from it] grows greater. And since the lines of the hours are marked [?] by [their own?] nature up to the great [point of] equality [?], [the reckoning?] of what is gathered [returns?] in this whole [reckoning]. Yet the measure of the hours [is known?] by [dividing?] the arc [?] in this whole [reckoning] — though the knowledge of what has elapsed falls short [?] in [precision?]; and no approximation [truly?] captures its time [?]... [is a matter?] to be examined [?].

## The Fourth Gate

[Red ink header: השער הרביעי] On knowing the measure of the hours (*ʾittot*) of the day, and for [every place upon?] the celestial equator (*meshaveh ha-yom*), and on

knowing the measure of the hours of each degree. [**Stage-5 CONTESTED (editorial):** an independent cold read of the tile gives this heading as *נטיית הגלגל המזלות לצדדי משוה היום* — "the **inclination/declination of the zodiac sphere** to the sides of the celestial equator" — not *עתות היום* "the hours of the day"; the body's *"the [hour] will be small/large"* would then be *"the **declination** will be small/large"* (astronomically coherent near equinox/solstice). A *נטיה↔עתות* near-homograph drift is plausible. Reading not resolved here — verify against the fol.131 table-of-contents and a cleaner witness before committing either.]

[Blue ink: הנה] Behold: the parts of the arc that lie between the degree upon which [the sun] revolves and the beginning of Aries (*rosh Ṭaleh*) and Libra (*Moznayim*) — and likewise the degree upon which the beginning [of the opposite sign?] revolves — [when] the pole is to the south of the degree; and likewise the parts of the arc between the degree [?] and the degree upon which it revolves, [are reckoned] according to their true order [?].

[Red ink: ואם תרצה] And if you wish to know the hours (*ʾittot*) for each and every degree: set the thread upon the degree [in question], and set the pointer upon it at that moment. Then set the thread upon the line of altitude (*qav ha-nogah*); and if it is in the northern degrees, the pointer will fall upon the descending parts of the declination (*nogah*), and the hour will be small. And if it is in the southern degrees, it will fall upon the ascending parts of the declination, and the hour will be large. And the distance of the parts from their beginning — until it becomes [half the day / one hour?] — is its measure —

⚠ RECOVERED: p.2 (fol.134v) Fourth-Gate opening. Now legible: the arc is reckoned between the working degree and the equinoctial points — the beginning of **Aries** (ראש טלה) and **Libra** (מאזנים) — with the pole lying to the **south** (לצד דרום) of the degree. The north→descending→small-hour / south→ascending→large-hour rule is confirmed, and the graduation the pointer falls upon is the *nogah* (declination) scale. Residual `[?]`: the terminal quantity ("until it becomes half the day / one hour") is not securely resolvable, and one ordinal in the set-up is partial.

# Roba' Yisrael — batch_005 (ff. 135r–135v)

## fol. 135r

[Tail of the Fourth Gate, top line, partly legible:] … the degree will be reckoned a degree for its day, up to [?] …

[Blue rubric header:] **The Fifth Gate** [השער החמישי] — On knowing the arc of the longest day, the arc of the shortest day, and the arc of the day in each and every degree of the sphere's degrees. … and the arc of its night [?] … for those whose longest day is a whole day long, or half [a day] or more, and the like.

[Red rubric:] **At the outset** [בתחלה]. To know it: set the pointer on the head of Aries and fix it in place; [set] the touching thread, and at the point where it cuts the divisions of the equator circle (*ʿagulat ha-shivvuy*), see how many degrees it cut off from it, opposite the … [?].

[Blue sub-rubric: an ~6-letter connective, read "ולדעת" (?) — "And to know."] To know the arc of the day in each and every degree: set the pointer on the degree whose day-arc — its half-day arc — you wish to know. Then hold the thread and set it as you would at the oblique horizon (*ke-ofek ha-noteh*). After that, see how many degrees the thread cut from the divisions of the equator, and the [ascensional] difference of the equator comes out for you. Whatever it is, add these degrees to the earlier ones (or subtract them in the degrees of the southern [signs], as the case requires); what results after the addition or subtraction is the arc of the half-day for that degree. And after [you have] the arc of the half-day, its equal [is subtracted/doubled], so that this is the arc of the day; and what remains is the arc of the half-night.

[Red rubric:] **[To know the arc of the half-night]** [נחם / connective rubric, read uncertain]. To know the arc of the half-night for a degree: see the arc of the half-day, [take] its complement from the divisions of the equator, and find [again] the [ascensional] difference of the equator. This will be [with] the degrees subtracted … in the degrees of the southern [signs]; and what results after the addition or subtraction … [several interior clauses below the cursive floor — see flag]. … [reasoning] for half a day and half a night. And likewise (*ve-khen*), by that same reckoning the longest day will be **twenty-[numeral: ?]** hours, and there remains [a fraction/hour, numeral ?]. And when the horizon [is set so] that their longest day [reaches its limit] … a person will have the whole [circuit] as a single [span] — half a day and half a night. And when the horizon [is placed so] that their distance from the pole (*merḥaqam min ha-qoteb*) is **twenty-[numeral: ?]** degrees … and we take … or the great meridian [circle] is [set aside] from its path toward the horizon and made to stand perpendicular over the earth (*niẓẓav ʿal ha-areẓ*) — then their longest day will be **twenty-four hours**.

## fol. 135v

[Red rubric:] **And likewise** [וכן] — if you set the thread on the line, southward (*ha-negbah*), and set the declination [Hebrew: read הנוגה / הנטייה here] at the distance from the pole — **[numeral: ?]** parts (*ḥalaqim*), approximately — and bring the thread until it falls on the equinoctial horizon (*ofek ha-shivvuy*), a change occurs in its force (*shinnuy be-koḥo*). It becomes apparent [at that place] … and it cuts off, from the degree of the beginning (*maʿalat ha-hatḥalah*), like the degree … at the extremities; and it grows smaller, so that the day at that [place] will be **[numeral: ?]** months (*ḥodashim*), like the measure of the sun's [circuit] …

[Blue rubric:] **And likewise** [וכן] — if the declination [read הנטייה / הנוגה] is increased upon the distance from the pole … and it cuts off from the pole … [a] degree; and the day at that [place] will be **[numeral: ?]** months (*ḥodashim*), like the measure of the sun's [circuit] in the time when … a quarter of a degree [?]. And when [reckoned] at the horizon at half its degree [?], the cut is at this place — it is the great [circle] upon which the head of Aries and Libra revolve (*rosh ṭaleh u-moznayim*), and it lies upon the line [?] … the horizon and the perpendicular for them, upon whatever [point of] latitude there shall be; and they shall have the whole [span] complete — a [single] day and half a night [?].

[Red rubric header:] **The Sixth Gate** [השער הששי] — On knowing the rising of the signs in the right sphere (*galgal ha-yosher* = right ascension).

[Blue rubric:] **At the outset** [בתחלה]. To know it: set the pointer on the degree [of the ecliptic] that corresponds [to the sign], in order to know … [and] see how many degrees it cut off from the equator sphere — these are its degrees [of rising], the rising as [in] the right sphere. Then set it likewise on the divisions of the [ecliptic] sphere at the [starting] place. [Red rubric: **And likewise** (וכן?)] — if you have degrees from the [ecliptic] sphere and wish to know the [corresponding] degrees in the right sphere, [set] the thread on the degree of the equator … and whatever it cuts off from the divisions of the [ecliptic] sphere, of the degrees … And know that the degrees near [it], from right to left, are a rising [reckoned] against the risings [?] … reversed … the shorter [arc]; and those to their left are [in] their [normal] order … [the remaining interior clauses of the reckoning are below the cursive floor — see flag].

[Blue rubric:] **And furthermore** [ודע — "And know" / read uncertain] — that you may proceed in this way in all the risings of the degrees in the right sphere, and their beginning [is a] degree. Therefore one must subtract them from these

[values] in their adjustment (*be-tiqqunam*), according to what the degrees will be … And keep in mind how much [that is] [?].

[Blue rubric header:] **The Seventh Gate** [השער השביעי] — On knowing the rising of the signs at [some] horizon … from the oblique horizon (*ha-ofek ha-noteh* = oblique ascension).

[Red rubric:] **At the outset** [בתחלה]. To know it: know how much [each degree] rises [?], in order to know their rising at the oblique horizon. First know each degree's rising over them as [in] the right sphere, and the degree that is the beginning. After that, set the pointer on the number of degrees on the sphere of the signs, further …

[The Seventh Gate continues beyond this folio.]

[Librarian note: foliation "136" in pencil, top-left corner of the recto.]

## Folio 136r — Seventh Gate (continued): the rising in the oblique sphere …of the right [sphere]. And also without the equalization of the degree [?] and its position — set the pointer (*morah*) upon it, up to the point marked [?]. Then observe what rises above at that horizon (*ofek*): this is its degree of ascension. Divide its degree into the parts of equality (*chalkei ha-shivuy*), apart from the equinoctial horizon (*ofek ha-shivuy*); the remainder then completes [the circle] in the right sphere (*galgal ha-yosher*). And whatever be greater than that [?] — a third of a third of a second [?] rises — at the oblique horizon (*ha-ofek ha-noteh*) [?].

[Blue ink display header:] **And so that you may gain insight and know [the method], I shall work out an example for you.**

[Red ink initial: "הרי" ("Now"), enlarged ~3 letters [?].] I wished [?] to know for it [the ascension] a known [?] degree at the horizon; and I summed its breadth (*rochbo* [?]) — behold, this. Upon them [?] … up to [numeral: ?] degrees [and] [numeral: ?] minutes (*dakim*) … the ascension [*ha-temurah*] at the horizon [?], up to the point where you set the pointer upon the given [figure]; and the observation upon the oblique horizon (*ha-ofek ha-noteh*) — behold, the parts (*machalkei*) differ. Its right ascension [*ke-shivuy* / "as at equality"] is [numeral: ?]

degrees [and] [numeral: ?] minutes; less [?] … [numeral: ?] degrees in the right sphere. And there came out for it [numeral: ?] degrees and [numeral: ?] minutes; and from the second … at the oblique horizon (*ha-ofek ha-noteh*) — behold, this it is.

[Blue ink sub-rubric:] **[?] the gradation (*ha-daragah*)** — [the operator-word before *ha-daragah* reads "וחס[?]"; a compute/subtract-the-ascension sub-step, exact word [?].] … [numeral: ?] degrees [and] [numeral: ?] minutes; and its right ascension [*ha-shivuy*], differing from the parts [?], is [numeral: ?] degrees [and] [numeral: ?] minutes; less [?], completing [the circle] in the right sphere; and it went up as far as the degree [numeral: ?], and this is its rising in the sphere. And this is [computed] up to a third of a third of a second [?] rising — to know upon them.

[Red ink sub-rubric:] **[?] the gradation (*ha-daragah*)** — [same operator-word "וחס[?]"] up to the end of what draws near [?], this is its rising, a third of a third [?] in the right sphere.

[Red ink initial [?]:] It will be [?] for that degree; and the greater part of the half [?] you will find upon it [?]. Therefore you must add [?] of the right ascension [*ha-shivuy*], and the greater part of them [is] the ascension (*ha-tosefet* / rising-time [?]). And if [it be] from [numeral: ?] up to [numeral: ?] [the boundary of the semicircle], the ascension will be found upon the example; and as [you did], [subtracting] from them the rising-time of the day — therefore you must add to what is found [?], less than them, the rising-time. And likewise, when [it is] from [numeral: ?] up to [numeral: ?], and at the time of the degree [?] you will find [it]; and less than them remains the day for that degree — [the degree] of the short day [?]. And the greater part of the half you will find [?]. Therefore you must subtract from the amount, less than them, the declination (*ha-netiyah*); and from [numeral: ?] up to [numeral: ?] it will be descending [?]. And when [?] the degree — behold, for that degree you must add [?] of the right sphere [?].

⚠ NEEDS HIGHER-MAG TILES — PARTIALLY RECOVERED: p.11 (136r) worked-example numeral run. At 500 DPI the connective procedure, the two colored sub-rubrics (recurring word "…הדרגה", *ha-daragah*, "the gradation," with an uncertain operator-word "וחס[?]"), the "third of a third of a second" fractional phrasing, and the semicircle add/subtract logic are now recovered and committed. The specific degree/minute (*maʿalot*/*dakim*) operands and the two semicircle-boundary numerals remain at the **cursive-glyph floor** — tiny 2-letter gematria in a rapid Sephardic semicursive where ז/ל, נ/ג, ק/ר are unresolvable without guessing; not further recoverable by DPI. Kept [numeral: ?] rather than filled.

## Folio 136v — worked examples (continued), then the Eighth Gate

the sum [?]. And he wished to explain how many are the ascensions belonging to those of [?]. Now, set the pointer [*shim*] upon the number, for every degree of [?], and for those of equality (*baʿalei ha-shivuy*); and set the ascension (*ha-temurah*) upon the degree that rises with it. And [when] we brought it near to the horizon — behold, the parts of equality (*machalkei ha-shivuy*) differ; for one of equality [?] at the equinoctial horizon [rises with] [numeral: ?] degrees, and behold, the rising-time of the day for that degree is greater [?]. And [when] the ascension is [numeral: ?] degrees [and] [numeral: ?] minutes, its right ascension differs from the parts [?]; this it is. And its right ascension, differing from the parts [?], is the whole rising-time, and you derive it [?]. And if [it be] for you a degree [numeral: ?] up to [numeral: ?] [and] ten [?], contrariwise; so too all that draws near [?] upon the degree — the rising-time of the day is [numeral: ?], for it [?] a certain part [?], and it does not [?].

[Red ink initial: "עוד" ("Further")[?]:] the amount that remains for the one of equality, [something] one, remains the rising-time of the day, they added it [?]; so too the ascension [?], differing [?]. Up to when it be a degree [rising] with the declination of the ascension (*ʿim netiyat ha-temurah* [?]) [?].

And behold [there are] [numeral: ?] degrees [and] [numeral: ?] minutes, less [?], from these degrees; therefore you must [?]. For one that rises [?] with [numeral: ?] degrees … and the right ascension it must [?] to the degree, and the greater part of them upon the degree [?]. Furthermore, you must know [?] the degree with [?] the degrees, to know the ascendant degree (*ha-maʿalah ha-tzomachat*) at the [degree] which is in the path [?].

[Blue ink initial: "ותחלה" / "ותחל" ("And begin / At the start")[?]:] the second [?]; and [when] you compute [?], the ascension of the degree at the horizon [is] to it [?]. And so, when the ascension be [numeral: ?] degrees … the boundary of [?].

⚠ NEEDS HIGHER-MAG TILES — PARTIALLY RECOVERED: p.12 (136v) worked-example continuation. Recovered and committed: the procedure (setting the pointer over the number for each degree and for the equal-degrees; the divergence of the rising-times at the oblique vs. equinoctial horizon; deriving the whole rising-time; the semicircle "contrariwise" add/subtract logic), and the term *netiyah* ("declination"). The summation-of-rising-times figures and degree/minute operands remain at the cursive-glyph floor (same 2-letter gematria limitation), kept [numeral: ?].

[Blue ink display header:] **The Eighth Gate** (*ha-shaʿar ha-shemini*) — on knowing the ascendant degree (*ha-maʿalah ha-tzomachat*) and the degree which is at the mid-heaven (*ba-chatzi ha-shamayim* — the culminating degree), by [means of? / at? [?]] its setting; and thereby the body [?].

[Red ink opener:] **At the outset** (*ba-techilah*) — for your knowledge, know how many hours and parts of an hour have elapsed … and you already know the arc of the sun (*keshet ha-shemesh*) from what preceded.

## Fol. 137r

**[Eighth Gate, continued — the ascendant degree and the culminating (mid-heaven) degree]**

[The passage continues the procedure begun at the foot of the previous folio.] … the complement which belongs to it. The complement that is in it, in the oblique horizon that you obtain for yourself, together with its arc, just as in what preceded this. Add before it a degree; and however many degrees remain, take them up — and the minutes that are within them — in that horizon. That degree is **the ascendant degree** (*ha-maʿalah ha-tzomachat*).

[Blue rubric: **עוד —** "Furthermore."] Take the arc of the complement which lies upon the right sphere (*galgal ha-yosher*), and subtract from it [numeral: ?]. Add before it a degree; of the degrees that result, take up the degree and the minutes within them upon the right sphere.

[Red rubric: **ולדעת המצב —** "And to know the culmination (*ha-matzav*, i.e. the mid-heaven degree)."] At the outset you already know the sun by them; … the degree of the sun upon the right sphere. And know the degree that lies upon the right sphere, and its minutes; place [the thread] upon it. What you obtain … in the oblique horizon — this is the culminating degree; and it is [at the position of] the sun, as at the equinox (*ha-shivvuy*).

For the reckoning of the hours is [numeral: ?] degrees [context: degrees of right ascension per hour] … upon all the degrees. And every degree and its minutes: when the degree is one degree, and the minutes … [there remain] [numeral: ?] degrees and [numeral: ?] minutes; and that is the degree of the culmination.

The last remainder, the degree that is deficient … [numeral: ?] degrees and [numeral: ?] minutes; and however many minutes there are, take them up as degrees upon the right sphere, and that is the degree.

[Blue rubric: **תדע** — "Know."] … the degree of the sun … upon the right sphere; place [the thread] upon it … [numeral: ?] degrees and [numeral: ?] minutes … and that is the degree.

[Red rubric: **והנה אמשיל** — "And now I shall set out an example."] … the sun shall be at the [numeral: ?] degree [of a sign / of Nisan? — the argument is uncertain], and already … [the worked example begins here and continues onto the verso].

## Fol. 137v

**[Eighth Gate — worked example, concluded]**

[The worked example continues from the recto:] … the sun with the degree, that is [numeral: ?] degrees and [numeral: ?] minutes, take it up … [numeral: ?] degrees; and there remain of them [numeral: ?] minutes; and take up the degree … the arc, and take up [numeral: ?] degrees; the degree shall be upon the right sphere with the arc, as before; and it is a degree and [numeral: ?] minutes. Add … [numeral: ?] degrees, and there remain [numeral: ?] minutes.

and this is the [ascendant / culminating] degree, and its minutes are [numeral: ?]; and take up … the degrees and their minutes; and there remain [numeral: ?] degrees, and they shall be [numeral: ?] degrees … and [numeral: ?] minutes, and they were [numeral: ?] degrees. … and if it [the sun / the star] is … [there remain] [numeral: ?] degrees; take them up as degrees … the arc upon the right sphere, and it is [numeral: ?] degrees, and they were [numeral: ?] degrees; and that is it.

For this reason it was so; and behold, the arc … Behold, and this is it. And now know the great arc.

Know the ascendant degree, and add a degree; and when it has been completed … the day; the sun which … the degrees that have passed of the day … from the day. That day … [there remain] [numeral: ?] degrees, and take up the degree … and it shall be the degrees … [there remain] [numeral: ?] minutes, and they are the excess of the day over … and it shall be at the equinox; and it shall be so … [numeral: ?] hours.

**[Ninth Gate — the position of the star, its night-arc and day-arc, and the degree that rises with it]**

[Red rubric: **השער התשיעי** — "The Ninth Gate."] To know the position (*ʿetzem*) of the star, and the arc of its night (*qeshet leilo*), and the arc of its day (*qeshet yomo*), and the degree that the star draws up (*yaʿaleh*) together with the [fixed stars] visible with it, and the degree [that sets with it].

[Blue rubric: reading uncertain — **כאשר** ("When…") is my best higher-magnification read; the first pass read **בתחלה** ("At the outset"). The word is a legible blue rubric but the medial cluster is ambiguous.] Know the position of the star (*ʿetzem ha-kokhav*), and the degree that rises now together with it; and the degree that is with … the arc of the day of the star. Place the thread upon the position of the star; and set it to the place of the rising of the star (*zeriḥat ha-kokhav*) in the oblique horizon, and see upon how many degrees the thread falls, of the divisions of the degree — the degrees of the equinox / the time-degrees (*maʿalot ha-shivvuy*).

If the star is toward the north, take up — add the day to the complement — up to the celestial equator (*meshaveh ha-yom*), as far as the place of intersection (*maqom ha-ḥittukh*); and that shall be the [rising] of the day. And if it is south of the celestial equator, see how many degrees of them [there are] … the degree of the equinox … the line of declination (*qav ha-neṭiyah* — the declination); and it shall be half the arc of its day.

And if you wish to know the arc of its day … see how many degrees the star's declination (*neṭiyah*) [gives], and the degree that rises with it, and it shall be … [numeral: ?] degrees; and it shall be the [rising] of the day.

And if you wish to know it for its night, see how many degrees rise with it of the degrees of the sky; and that shall be the arc of the night (*qeshet ha-lailah*).

and it shall be its declination (*neṭiyah*) … toward the north or toward the south … [numeral: ?] degrees; and if the star is not in the oblique horizon … at the [given] time, it shall not be at its rising and its setting; and this shall hold for the stars … in the [sphere?] … [text continues past the foot of the folio].

# Roba' Yisrael — batch_008 (ff. 138r–138v)

[Librarian note: "138" — pencil foliation, upper-left corner of 138r]

## Folio 138r — Ninth Gate (השער התשיעי), continued

and this is the limit. Now, such a star has no arc of day, for it stands above our horizon always.

And here is what will happen to you: when you set the thread (*ḥut*) upon the oblique line (*kav ha-noteh*) and mark the pointer (*morah*) at the degree of the horizon together with the oblique line, and mark the thread together with the [pointer?] upon the [scale?], [the star will stand] upon the horizon at another

point. And all the stars whose degree of passage [is thus] will be rising above the horizon always.

[Red ink rubric:] **And if you wish** to know the degree at which the star will stand — set the thread upon the position of the star (*etzem ha-kokhav*) and mark [with the pointer], [reading off] the [degree?] that ascends with it. [Two further procedural clauses of the same kind follow; several connective words sit below glyph resolution and are flagged [?].]

[Blue ink rubric:] **And if you desire** to know with which degree [the star] rises or sets — [take?] the degree that emerges, and how much it is, as above; and [set] the horizon upon the degree of the sphere [numeral: ?], and [take] the arc of the half-day of the star, and the remainder [is] the [numeral: ?]; [set] the degree... at the horizon [and] the declination (*ha-nogah*), and it is the degree with which the star will rise. Or, [if it be so,] add the half of the arc of day of the star to the ascension of the degree at which the star will stand — [numeral: ?] degrees with it upon the sphere — and by the degree of the declination the degree will come out for you.

[Red ink rubric:] **The example.** As, for instance, if it were required of us to know [the degree], let us say the degree that will rise; [we set the thread upon the place of] the star, and we saw the thread cut at [numeral: ?]... the long degree; and it is the degree at which the heaven[s] will be found with it. After this we saw upon it [numeral: ?] upon the sphere, which is [numeral: ?] degrees; we added to them [numeral: ?]... the arc of day of the star, which is [numeral: ?], and there remained [numeral: ?] degrees; we saw the equalization [circle], [and] the ascension was [numeral: ?] degrees — and it is the degree with which this star rises. And if we had added [it] to the half of the arc of day of the star, the whole being [numeral: ?] degrees, [numeral: ?] degrees, we saw the equalization [circle], [and] the ascension, and it will be [numeral: ?] degrees, [numeral: ?]; and it is the [angle?] at the time [the star] sets...

[The example runs on for several more lines in the same pattern — cut-degrees read off the equalization circle, sums, and the residual degree — each operand a two- or three-letter gematria numeral with gershayim. The tens-place is often legible but the units letter sits at the ק/ר–נ/ג–ל/ז cursive floor; the operands are therefore withheld as [numeral: ?] rather than committed. Text ends near the foot of the written block; the lower margin of 138r is blank parchment.]

## Folio 138v — the Tenth Gate (השער העשירי)

[Blue ink heading:] **The Tenth Gate,** on knowing the ascendant degree (*ha-maʿalah ha-tzomachat*) and what rises in the portion of the heavens, according to the **altitude** (*govah*) of a star [Stage-5 corr.: a prior pass read "the declination (*neṭiyyat*) of the star" here — the tile shows גובה "altitude," pulled to "declination" by contamination from the gate body; "[setting? degree]" had no visible שוקעת and is removed] in this [reckoning?].

Take any star you please of the remaining [fixed] stars by this same rule.

[Red ink rubric:] **When you wish** to know [this] — take the [oblique] line belonging to the star that you are computing, from among those you have computed, and take its declination (*ha-nogah*), which is the [degrees?] you have worked in it, [as near] to the truth [as you can]; and [take] its arc together with the [ascending] degree of the star you are computing, by the one declination; and [set] the thread upon the place of [intersection?], the degree of equalization (*meshaveh ha-yom*), and [observe?] the declination toward the south. And after you have known [these], do as [we said] before.

[The gate then works this through:] whether the declination lies toward the east or toward the west; and — if the star is northern — you add [it] to the degree, and if it is southern you subtract [it] [?; the north-add/south-subtract branch is present and "southern" (*deromi*) is read with confidence, but the paired add/subtract verbs sit at the resolution floor]. [Then take] the altitude of the star that rises together with it. And if it is [small?], add it... [numeral: ?].

Add the length of the degree (*orekh ha-maʿalah*) to the ascension of the degree at which the star is found together with the heaven; and the sum is the ascension of the ascendant degree — [this is] the degree at which the star will stand. And [combine?] the ascension of the degree... at the horizon [with] the declination; and that degree is the degree [numeral: ?].

[The closing lines treat] knowing the [whole?] gate together with the ascendant degree [belonging] to your time at that horizon, so that [the sum] be the arc of the gate, [from] the gate of the sun [numeral: ?] to the moment... and after you have known the ascendant degree and its [keeper?] in the portion of the heavens, [you can] know [the rest].

[Green/olive ink rubric, faded but now legible:] **ולפי** ["And accordingly"] [followed by faded text] … in the [first?] reckoning … and they are required in order to know the [whole?] gate …

[Marginal foliation, upper left: "139"]

the star, which is at the tenth degree — a fractional part of a degree — and its altitude [*gavho*] was [numeral: ?] degrees toward the east. And you wished to know how many hours it was [i.e., the time of day]: it comes to eight and a half [degrees] in the degrees of equality [equinoctial degrees], and the pointer [*ha-morah*] upon its rising that day [gives a value], until you set it upon the altitude that we took. Now the part [indicated by] the pointer, out of the seasonal hours [*ha-shaʿot ha-zemaniyot*] belonging to the star that day, is [numeral: ?] hours; and the part that has already passed is [numeral: ?]. Therefore the arc [*qeshet*] of the star is [numeral: ?] degrees — the arc-degree at which the star crosses the sky.

[The passage continues as a computation: it takes the star as being in the southern [part], works with half its revolution [*ḥatzi mahafakho*] and adds half of its [complementary] revolution, and combines these with the equinoctial degrees to yield the elapsed and remaining hours. Several of the two-letter operand numerals remain below reliable glyph resolution even at higher magnification — flagged individually below; not committed.]

and we reckoned that the star, being in the southern [region], is [at] half of its revolution; and you add half of its revolution, a small part. The degree of this small part of the star is [numeral: ?] degrees [...] about eight hours, which we examined; and the sum [*ha-meḥubar*] was [numeral: ?] [...] the degree that is toward us; and the star [crosses] the sky now at [numeral: ?]; and the whole was [numeral: ?] — and this is the [required] degree that has been reached [*ha-nigmeret*]. And if you wish to reckon it [the other way], you find the declination [*ha-netiyah*], which is southern, [numeral: ?] degrees [...].

[Red ink, inline: ועוד ("And further")]...[a further case:] the star is at [numeral: ?] degrees [...]. We took the altitude of the star, and it was, in the degrees of equality, [numeral: ?] [...], and the pointer upon its rising that day [gives a value] [...] until you set it upon the altitude that we took. And behold — [the same procedure applies]: the seasonal hours belonging to the star, the part [indicated by] the pointer, and the arc [combine] so that [numeral: ?] [...].

[The remainder of 139r is a parallel worked computation — arc of the star, the crossing of the sky, half-revolutions added and subtracted, and the equinoctial degrees — carried through to a total. The operand and result numerals are at or below glyph resolution and are flagged, not committed.]

therefore the seasonal hours [...] and it was [numeral: ?] [...]; and if [you subtract] [numeral: ?], then the arc of the star [is] [numeral: ?] degrees, and [there remains]

[numeral: ?] [...]. And this is the [rule]: the star crosses the sky now at [numeral: ?]; and its arc [...].

the degree, and behold — this [gives] its rising and its crossing [of the meridian]; if you took [it] correctly, it will be [correct], and the remaining degree will be [numeral: ?] [...]. And if you added and subtracted correctly, the degree of rising [*ha-maʿalah*] and the [degree of] crossing [will agree]. So, for example: [take] a star [whose altitude], in the degrees of equality, [is] [numeral: ?] degrees [...], and the pointer upon its rising [gives a value], until you set it upon the altitude that we took. And behold, this [is] the arc of the star: [numeral: ?] degrees [...].

[The computation continues across several lines: the seasonal hours, the part [indicated by] the pointer, half-revolutions, and the total. The recurring result value is committed below; the smaller operands are flagged.]

until the crossing of the meridian [*ḥatzi ha-shamayim*] upon its part that day [gives] [numeral: ?] hours [...], and the passed part is [numeral: ?] [...]; and there remains [132] קל״ב degrees [...]. Combine, and further [reckon], and there remains [132] קל״ב degrees [...]. And if [it agrees], then [numeral: ?] hours and [numeral: ?] minutes [*ḥalakim*].

[Blue ink, inline: ואם ("And if")]...[a conditional case:] the star [is] to the other side [...]. [If] you took the altitude of the star to be [numeral: ?] degrees [...], and [numeral: ?] [...], the crossing of the sky [*ḥatzi ha-shamayim*] [...]. And if [it is] such-and-such, then the arc [is] [numeral: ?] degrees [...]; and [there remains] the crossing of the day, [numeral: ?] [...], with [numeral: ?] minutes of an hour, [i.e.] two minutes; and there remains [numeral: ?] [...].

[The paragraph continues, treating the star both east and west, adding and subtracting half-revolutions and reconciling the two determinations of the crossing. Numerals flagged.]

concerning the fixed stars [*ha-kokhavim ha-qayamim*], the pointer [...], and [numeral: ?]. And this is [the case] where [the star] is always [so]; and we verified it by the degrees of equality [...], and we knew and reckoned [...], as we [explained] above, [numeral: ?] [...].

[The following lines rehearse the general rule: knowing the star's altitude and the equinoctial degrees, one derives the ascendant and the crossing; the argument names the pointer [*ha-morah*], the seasonal hours, and the half-revolution. Numeric constants flagged.]

upon the degree of the [ecliptic] signs [...], and this [is] the [required] degree that has been reached; and now, thus [we have shown it]. And behold, this [is] the crossing of the lesser [arc] — so it is with the tested degree [*ha-nivḥar*], the fixed [stars] [...]; and if you add [...] the pointer [...], as [it was] with the first star [...]; and by the labor [of the computation] you understand [...] a second time [...]; the degree of the signs [...]; so, when the star [is] small [in altitude] it is [numeral: ?] [...].

[Red ink, inline: המשל ("The worked example")] In this [example] we took [a sighting] toward another star — [reckoned] as equal [to it] in the crossing of the meridian [*ḥelek ha-shamayim*] — and let its altitude [*gavho*] be [numeral: ל? — a value in the thirties beginning with lamed; second glyph unresolved] degrees. And we knew and reckoned the breadth [*merḥav*] up to another star [...]; the degree that [is] [...] in the crossing of the meridian, how much it was; and it is the tenth degree [*ha-maʿalah ha-ʿasirit*] [...]; the second [...].

⚠ HIGHER-MAG RECOVERY DONE — residual cursive-floor numerals: p.1 (139r) — connective prose confirmed against the 500-DPI strips; the spelled-out numbers "tenth" (עשירי), "eight and a half" (שמנה וחצי), and "about eight hours" now read cleanly and are committed. The two-letter gershayim operands (altitude in degrees, seasonal-hour counts, arc-of-the-star degrees, elapsed/remaining hours, the "reached degree") remain at or below glyph resolution on these full-width strips and are NOT committed. "Half its revolution" (חצי מהפכו) is confirmed as a phrase, not a numeric constant — no 180° value is inked.

⚠ HIGHER-MAG RECOVERY DONE — residual cursive-floor numerals: p.2 (139v) — recovered and committed: the recurring result value [132] קל״ב in the "and there remains" (וישאר / הנשאר) slot of the parallel computation (three-letter numeral with clear gershayim, occurring in two parallel positions; first glyph carries a descender favoring ק over ר — literal-glyph reading = 132); "tenth degree" (העשירית, spelled out) confirmed; "two minutes" (שתי חלקים, spelled out) confirmed. WITHDRAWN: the first-pass candidate "לט = 39" for the המשל second-star altitude — at higher magnification the initial ל is clear but the second glyph does not resolve (tet/he/gimel/vav indistinguishable), so the value is downgraded to [numeral: ל?s ~ 30], NOT committed as 39. The "tenth degree" ascendant reading is CONFIRMED (spelled העשירית, not a gershayim numeral). Remaining two-letter operands flagged, not committed.

[Foliation: "140" in modern pencil, top-left corner of the recto — a cataloguer's/modern foliation, not part of the text.]

## [fol. 140r]

[The recto has a blank upper margin (normal layout, not a lacuna); the text block occupies the central portion of the page, continuing the worked examples of the risings/ascensions gate begun on the preceding folios. A blank foot margin follows the text block.]

was [numeral: ?] degrees, and the star fell short of the degree — it reached likewise [numeral: ?] degrees. So we know that the ascension of the day toward the south side is [numeral: ?] degrees, just as we had posited it to be in the part corresponding to the star's ascension. Then we passed the thread over the degree of the lagging [signs] (*miṯʾaḥarim*), and it was found correct, and we take their ascension. We passed it over the pointer, and it then cut [numeral: ?] degrees of the lagging [signs] — and that is its mean place. Its true remainder from the degrees… the degree came to [numeral: ?]; there came out [numeral: ?] degrees toward the south. And if the star should fall upon the degree…

[the star's true place?] — now the degree is [numeral: ?] degrees, which remains… The star that remains with us and the star that is [?] from the [numeral: ?] degrees — this star lies within [numeral: ?] degrees, and that is its place; and it came out [numeral: ?] degrees of the lagging [signs], and that is its mean place. Its remainder from the degrees…

and the star… among the signs, and that will be its place; and as for the star that is nearer, from the [?] star — this is the place of the star. And it comes out toward the south side [numeral: ?] degrees; and its place among the signs is its true place, and its remainder from the degrees is [numeral: ?] degrees of the lagging [signs]. And behold, the star that is [at/short of?] the degree — its ascension is that which came out; and its place among the signs is [numeral: ?] degrees, and it is the lagging [sign].

The star that came out — its position, with the star that [reaches?] the degrees toward the south side, is [numeral: ?] degrees. And behold, the ascension… among them, upon the pointer… and when it comes out to the degree… [numeral: ?] degrees, and its place among the signs is its true place; and if…

And by this reckoning you will always know the star's degree. Behold, if it is [at?] the degree [numeral: ?] — behold, if you took its altitude and it was [numeral: ?] degrees toward the south side, its ascension… now the star's altitude toward the south — behold, its ascension is [numeral: ?] degrees; and if it were a [northern?] star, behold its remainder is [numeral: ?] degrees. So too, if you took the altitude

of the… the degree is this degree, and the star's [altitude]… among the signs is its true place… [numeral: ?] degrees toward the south. And when the star's altitude is [numeral: ?] degrees, its ascension is [numeral: ?] degrees…

the star that is with us by this reckoning, and the position… among them; and it is [at?] the star, and its place among the signs is [numeral: ?] degrees toward the south; and if the star's altitude was [numeral: ?] degrees, its ascension is [numeral: ?] degrees of the lagging [signs]…

this is the star's ascension, and its remainder from the degrees is [numeral: ?] degrees; and it is the star that is [at?] the degree, its place toward the north side… [?] the star, and its remainder [numeral: ?] degrees toward the south; its position by this reckoning is [?] star, and it is [numeral: ?] degrees toward the south.

## [fol. 140v]

[the star's] mean place toward the [?] side; and the star, if it does not… outside… To bring it up to the meridian (*ḥatzi ha-shamayim*), and the way will be… for every star that… stands still… when its place is the degree that cuts [the meridian?]; and if [?] were as [we said?] in this rule. And if… as [we explained?] in this. — **[Red ink:] Know** (*da'*) that the star… in the degree of the pointer, whether to the north or to the south, and its place at this time will be…

behold, it will pass with the degree that is the strength of the meridian [?], and it will not… its place; and if the star… behold, the star… and the star's ascension among the signs is the degree that comes before it… the degree, from the place of the star; and its remainder… as it was at first, it rises; and so too from the place of the star, at the end of… behold…

thus to teach whether the star — its ascension is its true place, and the star's ascension among the signs is the degree that comes before it… the degree, from the place of the star; and its remainder… behold, it is the lagging [sign]; and so too the… like the ascension that is in the meridian, upon which this… ascension rose… among the signs at first, so its ascension in the degree… its ascension in the meridian rose first… every degree… and if it comes… behold, the star's ascension is that same degree; its ascension… and if it was in the meridian… rose…

behold, this is the ascension — that the star's ascension is [?]. And behold, if you took the star's altitude… now set the degree… the ascension that is in the star; and if it comes out toward… behold, the ascension is the star that is [at?] the degree, and there comes out [numeral: ?]…

**[Blue ink:] If** (*im*) by this [reckoning] the part is small… [?] the star's day, the altitude taken, and divide it… in it… in the ascendant part…; and there came out the declination (*nogah*) upon it. When its time was [known], the ascension that is in the star — its position [is] this ascension… [numeral: ?] degrees; or add the altitude toward the degree's side… its place among the signs. And there comes out the star's ascension, which stands with them among the signs, [?] the star; and if [numeral: ?] degrees and [?] the degree, behold, [?] the star, and it is [numeral: ?] degrees.

**[Red ink heading:] The Eleventh Gate** [הַשַּׁעַר הָעַשְׁתֵּי עָשָׂר]: On the knowledge of the ascensions (*ha-matzʿadim*) of the signs — the direct (*ha-yesharim*, the right ascensions) or the inverse (*kenegdiyim*, the oblique); or the knowledge of the [risings?], one by one.

**[Blue ink:] When you wish** (*kesheratzeh*) [to know] this: set the thread upon the degree whose [ascension?] you wish to know… upon the part that is known, and at the point where it cuts… the degree of the meridian of the day, set upon it the pointer (*ha-moreh*)… the thread; then divide the time [required?]…

[Librarian note: "141" in pencil, top-left margin of the recto (Latin foliation).]

## fol. 141r

*(The Eleventh Gate continues from the foot of the previous folio — on knowing the ascensions of the signs, direct or inverse. The following method-restatements are in compact Sephardic semicursive; at 500 DPI the recurring technical terms read confidently — the pointer [ha-morah], the thread [ha-ḥut], the degree of the equator [maʿalat ha-shivui], the arc of rising [keshet ha-mizraḥ], the ascensions [ha-matzʿadim], the oblique horizon [ha-ofek ha-noteh] — and much of the connective structure is now recoverable, though a few operands remain at the cursive floor and are flagged.)*

And at the place where the pointer falls among the degrees of the direct ascensions, that is the rising-point [mizraḥ] for those degrees. And likewise, if you already have a rising-point known and fixed for you [?], the pointer standing over that rising-point is one and the same; and when you have carried the thread across the degree of the equator to cut the day, then at the place where the day cuts, that is the arc of rising for that pointer. [?]

Likewise, if you wish to know the ascensions for the number of degrees and to raise the remaining degrees [?]: set the thread on the degree of the equator, at the number of those degrees, and set the one pointer over the degree of the day, and

the second pointer over the [?] rising-point [?]. Then carry the thread across the degree of the equator, and at the place where the first pointer falls, that is the direct rising-point for those degrees; and at the place where the second pointer falls, that is the direct rising-point for the remaining degrees. [?]

[Red ink rubric-marker: **ואם** ("And if")] And if your desire is to know the ascensions of the direct signs, which are called "the rising direct" [?]: set the thread on the degree of the equator, at the opposite point [?], and afterward carry the thread across; at the place where the pointer falls over the degree of the equator, those are the derived degrees of the ascension, first for [?]. [?]

[Blue ink rubric-marker: **ואם** ("And if")] And if your desire is to know the ascension of the degree [?] derived from the thread — over the crossing-point which lies nearest [to the moment of rising?] — proceed with the degrees of the equator. And at the place where the pointer falls over the degree of the equator, that is the rising-point [mizraḥ]. [?]

[The whole Eleventh-Gate ascension-method restatement (direct / inverse and lagging cases) is now largely recovered at 500 DPI; the method vocabulary and connective structure read confidently, and only a few interior operands remain flagged `[?]`.]

And what falls over it among the degrees of the direct ascensions, there will be the direct pointer. [?]

[Red ink header:] **The Twelfth Gate** (*ha-shaʿar ha-shneim ʿasar*) [Subtitle, same rubric line, black ink, one line only:] So that [one may] know [?] … where [heikhan?] … [?] [Subtitle now partly recovered: the opening formula (כדי שתדע~ / "so that you may know") and the word *היכן* ("where") read, but the intervening object-clause and closing words remain at the cursive floor. Do not supply from expectation.]

## fol. 141v

*(Body of the Twelfth Gate. Same compact method-prose.)*

[Blue ink rubric-marker: **כשתרצה** ("When you wish")] When you wish to know [?] … the beginning of the sign which is over the horizon [?]: set the thread on the degree of the equator, and reckon the ascensions one by one, the pointer over each one. Then at the place where the thread meets the beginning of the sign [?], that is the rising-point [mizraḥ] for that degree. [?]

The direct signs rise over [the equator?]; and if the sign is inverse [ha-hafuch], the ascension over the oblique horizon lags [?]. [The recurring direct-vs-inverse contrast of the Eleventh Gate is restated here for the star / altitude method of the Twelfth.] [?]

[Red ink rubric-marker: **ואם** ("And if")] And if the sign is [inverse?] [?]: set the thread on the opposite degree, and afterward the derived ascension over the equator [?]; and reckon it over [the oblique horizon?]. [?]

[Blue ink rubric-marker: **ואם** ("And if")] And if [?] … the ascension from the crossing-point [?] of the oblique horizon — the derived ascension over the equator is inverse. [?]

[The Twelfth-Gate method body (direct / inverse ascension via a star and the degree of the equator) is largely recovered; method vocabulary and the direct/inverse refrains read confidently. A minority of interior operands remain [?] at the cursive floor.]

[Blue ink header:] **The Thirteenth Gate** (*ha-shaʿar ha-shloshah ʿasar*) [Subtitle, black ink, running from the heading line onward — now substantially recovered:] So that you may know, at whatever hour of the night you wish [*bshaʿah she-tirtzeh me-ha-laylah*], how many [hours] have passed [?] — and part of the day [*u-ketzat ḥelek ha-yom*]. And this is by means of [?] the declination of the star [*nogah ha-kokhav*]; and we shall know the part of the day [?]. [Recovered anchors: *כדי שתדע בשעה שתרצה מהלילה* / "so that you may know at whatever hour you wish of the night", *וקצת חלק היום* / "and part of the day", *נוגה הכוכב* / "the declination of the star", *ונדע* / "and we shall know". The intervening quantity-clauses (how many hours; the worked example beginning *כמו שתאמר* / "as you would say") remain partly [?].]

[Foliation: "142" — librarian pencil, top-left margin of 142r]

## Fol. 142r

[Red ink: When you wish] this: place the thread on the divisions [מחלקי] [?], [reading] the divisions of the meridian [מעגל חצי היום]; then take the number [?] — as you wish — of the day and its declination [נטיה = declination], [placing] this pointer [המורה] on the circle [?], and set the [portion] of the day. [Set] the pointer on the horizon of the equinox [אופק השווי], and by the completion of what you have stated [?], the first pointer [gives] the divisions of the direct divisions [המחלקים הישרים]; and by this, what you find with this second pointer [gives] the divisions of the inverse divisions [המחלקים הכנגדיים] — and retain it.

⚠ NEEDS HIGHER-MAG TILES (partial recovery): p.1 (142r) lines ~1–4 — the recurring technical terms are secure (המורה pointer, מעגל חצי היום meridian circle, אופק השווי equinoctial horizon, המחלקים הישרים/הכנגדיים direct/inverse divisions, נטיה declination); the operational verbs ("place / take the number of…") and their exact objects remain at glyph resolution.

After that, place the thread on the number of this meridian altitude [גובה חצי היום], and set one of the pointers on the circle of the meridian, and direct it toward the horizon [?]. Then what this pointer gives — of the direct divisions [המחלקים הישרים] — you take up [?]; and what comes out in that portion, [with] the second pointer, is the remainder [?]. This is the direct pointer [המורה], and the remainder [?].

Then it will be a whole chord [מיתר]. Place the thread on the horizon of the equinox and set that number [with] one pointer, and draw the thread until it is upon the altitude [גובה] [?]. What the thread then cuts is the number of [?] of the hour [שעה]; and there remains [?] in it up to mid-heaven [חצי השמים], if it is before midday [קודם חצי היום] — [then subtract it / correct it] [?] by the portion [מקצת] of midday [?]. But if it is after midday [אחר חצי היום], add it [הוסיפהו]; and what results after the arc [קשת] [?]. [?] the hour [?] of the sun; afterward you apportion within it the portion of the arc [חלק הקשת] in proportion to the number of the hour according to its measure [כפי מדתם] — and by this it comes out, by way of number [דרך מספר], [as] what has passed of that day. And what remains [?] will be the fractions of the hour [שברי השעה] which are cut off in it [?].

⚠ NEEDS HIGHER-MAG TILES (partial recovery): p.1 (142r) lines ~7–16 — the before-/after-midday rule is now firmer: the thread's cut yields the number of hours; if before midday the value is reduced/corrected against the midday portion, and **if after midday it is added (הוסיפהו — securely legible)**; the arc-portion is then converted into hours proportionally ( … חלק הקשת … כפי מדתם … שברי השעה). Structural spine recovered; several operands and the exact before-midday verb remain uncertain.

[Blue ink: Moreover — ועוד, mid-page connective.] Proceed likewise with what remains, in another way, as we have stated: the thread on the number of the declination [נגה = declination] [?]…

## Fol. 142v

And by this you can know the ascending degree [מעלה הצומחת = the ascendant] and the setting degree [השוקעת = the descendant] and [the degree] at mid-heaven

[חצי השמים] on any night, from the star. For the star — when you place the thread on the number of the degree of the star [?], and one pointer on the circle of the meridian; then place the thread on the number of the [rising] degrees of the ascendant [הצומחת] which follows [?], and the second pointer on the circle of the meridian, and direct the thread to the horizon of the equinox. Then, as much as the first pointer falls upon of the direct divisions [המחלקים הישרים], [take that] with the pointers; and likewise what the second pointer falls upon of the direct divisions you carry over [?].

⚠ NEEDS HIGHER-MAG TILES (partial recovery): p.2 (142v) lines ~1–8 — the two-pointer procedure is now legible in its spine: first pointer on the meridian circle at the star's degree, then the thread and second pointer at the ascendant's degree, thread directed to the equinoctial horizon, both pointers read against the direct divisions (המחלקים הישרים). The closing subtraction (what one pointer gives, taken from the other) and the operands remain uncertain.

Then the pointer of the meridian [המורה על חצי היום] gives, upon the divisions [מחלקים], the number [?]; and what the second pointer falls upon of the direct divisions, that is the remainder [?]. The first pointer is the [?], and the remainder, if it be [?], is the setting [degree] [?]. And when you have subtracted [כשעברת] [?] one from the other upon the circle of the meridian, then what [remains] is the degree [?].

[The passage closes Gate 13 — the two-pointer method for the ascendant, descendant, and culmination at night from a star, resolved by subtracting what one pointer gives from what the other gives.]

[Red ink header: השער הארבעה עשר — The Fourteenth Gate]

On knowing the latitude [רוחב] of your place [רחב מקומך] [?]. [The two black lines of the gate's opening rubric are dense; **whether longitude (אורך) is also named is not legibly recoverable — not supplied from expectation, left flagged.**]

⚠ NEEDS HIGHER-MAG TILES (partial recovery): p.2 (142v) — Gate-14 opening rubric. "רוחב / רחב מקומך" (latitude / the latitude of your place) is now **securely legible** in the black intro line and again in the blue method-opener below. The remainder of the intro wording is at glyph resolution; **longitude (אורך) is NOT legibly named** — deliberately not supplied.

[Blue ink: When you wish] to know the latitude [לדעת רוחב]: place the thread on the divisions of the ascending degree [מחלקי המעלה הצומחת] [?], [and] set the pointer [המורה] upon the likeness [דמיון] [?] of [?]; take the declination [הנטייה =

declination] [?], [set] the pointer upon the degree of [?] the day, and direct the thread to [?] the equinox [השווי]. As much as the second pointer [gives], apportion it by [?] what the first pointer falls upon — and what [remains…]

⚠ NEEDS HIGHER-MAG TILES (partial recovery): p.2 (142v) final ~3 lines — Gate-14 opening method: thread on the divisions of a degree, the pointer set to a "likeness," the declination (הנטייה) taken, first/second pointer read at the equinox. Spine legible; operands uncertain.

# Roba' Yisrael — batch_013 (ff. 143r–143v)

Script: Sephardic compact semicursive, one hand, dark well-preserved ink. Bicolor rubrication (red + blue initials/headings), continuing the manuscript's established convention. Top third of both folio sides is blank parchment; text occupies the lower two-thirds.

` items and first-pass corrections.]

## fol. 143r …that it be. Seek out their number (*misparan*) along the celestial equator (*ha-mishveh*), set upon it the opposite-facing pointer (*ha-morah ha-nokhaḥit*), and reckon them by the measure of the divisions of the day; that [reading] off the divisions of the celestial equator is the latitude (*roḥav*) and the declination (*ha-netiyah*); and sight it toward the south (*darom*) [?].

[Red-ink initial (rubric word at head of strip, partly abraded — `[Red ink: [?]]`).] …the way: set the thread (*ha-ḥut*) on the divisions of the celestial equator according to what falls, up to the degree of the meridian (*maʿalat ḥatzi ha-yom*). Extend [the thread] by the divisions of the celestial equator, and set the pointer on the degree [above] the meridian. Again, set the thread on the divisions of the celestial equator by the divisions [?] that the equator rises, and set the pointer on the degree [above] the opposite point (*ha-nokhaḥ*). Extend [the thread] and see how many divisions each of them cuts off from the divisions of the equator's horizon — the direct ones (*ha-yesharim*) — and reckon [?] them.

[Recovered: the twice-repeated operative formula "set the thread on the divisions of the celestial equator" and "set the pointer on the degree of the meridian / of the opposite point" now reads cleanly at higher magnification; the still-`[?]` items are

the interior linking quantities and the ordinal *reckon/count* verb, which stay at the cursive floor.]

Now all these things [depend upon] the divisions of the equator that the thread cuts, upon [reckoning?] … [that] the head [of the sign] rose in your land [?]; and set the opposite-facing pointer on the degree of the meridian [?] until the thread [reaches] the degree of the equator, by way of subtraction [?]; and [take] the degree [of altitude]. And this is the latitude of [another? *aḥeret*] declination [?]. Set the pointer on the degree of the meridian, and the surplus [portion] of the thread up to the equator's horizon — [reckoned] by the direct divisions [?] — and accordingly the pointer falls upon us [?] …

[Red-ink initial: **וכן** — "And likewise,"] so too, in each one [of them], and by [the divisions] that the thread [cuts] from the divisions [of the meridian] at the opposite point (*ha-nokhaḥ*), we set the pointer on the degree of the meridian until …

[Blue-ink initial: **ואם** — "And if…"] it be difficult to know the latitude by the middle [method] [?]: when it is [taken from] the altitude of the [star? *kokhav* [?]] at the opposite point [against] the celestial equator [?] — examine closely whether it is northern or southern (*ẓefoni o deromi*) … and in the [selected/higher] horizons (*ofakim*), in this way, in every horizon its portion (*ḥelqan*) will be [?] … [strip ends].

## fol. 143v

[Gate 14 continues — the worked example.]

from the place [?] as though its head rose upon this horizon; and if it be by deficiency (*be-ḥisaron*), as in another horizon [?] — then we take [?] the measure from the day, by the divisions of the day [and] the degrees, and we divide by it the divisions [?]; and by this rule [?] that will be the declination (*ha-netiyah*), which lies opposite to the other horizon; and the horizon that rises after the elevation (*ha-qomah* [?]) is the degree of the [?].

[Red-ink rubric: **המשל** — "The Example."] In this: if [we take] a place (*ofek*) whose latitude is [numeral: ?] and whose [breadth?] is [numeral: ?] [?] — such that there be in it a place [?]; for behold, this place [?] treads upon [?] … the elevation (*ha-qomah*).

[Blue-ink initial: **ואם** — "And if…"] one wishes to know the measure [?] — [what] the whole [circle] traverses in the time [?] — [set the pointer] on the degree

[above] the meridian … and choose according to [what falls?], whether direct or inverted (*yashar o hafukh*), in the manner I have shown you in Gate [?].

[Recovered structure: the *המשל* worked example is confirmed to posit a place defined by its latitude (and a second quantity), then apply "the whole rule"; the direct/inverse (*yashar o hafukh*) pointer clause and the internal cross-reference "in Gate [?]" are legible in structure. **First-pass correction:** the floated example-latitude 40 = *מ׳* does NOT resolve to a confident glyph at 500 DPI — the character after *רחבו* is at the ק/ר–נ/ג cursive-ambiguity floor — so it is downgraded to `[numeral: ?]`; not committed. The earlier-gate cross-reference numeral is likewise not legible.]

## The Fifteenth Gate

[Blue-ink heading: **הַשַּׁעַר הַחֲמִשָּׁה עָשָׂר** — "The Fifteenth Gate."] [Subtitle, black: *בידיעת שעור גובה כל דבר גבוה וידיעת עומק [כל דבר עמוק]* — "On knowing the measure of the height (*gova*) of every high thing, and knowing the depth (*ʿomeq*) [of every deep thing]."]

[Red-ink rubric: **פתיחה** — "Introduction."] It has, moreover, a use — [namely for every] high thing and every low thing, and all things that lie deep — as follows. Take the instrument in your hand and set it up [?], facing [the object] until we sight the star [or: the top] of the thing whose height (*gova*) we wish to know. [Set] the thread on the divisions of the celestial equator, and [draw] a line as a thread upon the [?] …

[set] the pointer on the degree of the meridian … and choose according to what [falls], whether direct or inverted (*yashar o hafukh*), in the manner I have shown you, in Gate [?] — the pointer, either [singly] or by two sightings (*shtei reʾiyot* [?]); and after we know the latitude [?] in all [cases] … that they be … [strip ends].

[Recovered: the Gate-15 heading, its subtitle naming both *gova* (height) and *ʿomeq* (depth), and the *פתיחה* rubric are confirmed legible; the opening procedure — take up the instrument, sight the object whose height is sought, set the thread on the equator divisions, set the pointer on the meridian, apply the direct/inverse rule — now reads to sense, though several interior tokens and the cross-referenced gate number remain `[?]`.]

# Roba' Yisrael — batch_014 (ff. 144r–144v)

*Primary hand: Sephardic/Provençal compact semicursive, dark well-preserved ink. Bicolor rubrication (red and blue) used here only for the successive case-openers* ***ואם*** *("And if"), which alternate blue/red down the passage. No gate heading, diagram, or table appears in this opening — Gate 15 (measuring the height* [gova] *and depth* [ʿomeq] *of objects) continues throughout, and Gate 16 has not yet begun.*

## Fol. 144r

[Foliation "144" in the upper-left margin.]

[Gate 15 continues from the foot of 143v.] …will follow from this. Know that if the digits [*ha-etzbaʿot* — the shadow-square graduations the thread crosses] read twelve [י״ב], then the distance between you and that object [stands to the full scale] just as the height of the object [stands to it]; reckon it by the line of your counting at your point [*bi-qav sifrekha, nequdatekha* (?)]. And if the digits give more than this or less than this, reckon the height accordingly.

For once you know [the ratio of] the digits to twelve, you likewise know [the ratio of] the perpendicular [*ha-nitzavah* (?)] to the distance [*ha-merḥaq*]. And when the object is a deep one [i.e. you are measuring depth], the whole is found by the same reckoning, by the graduation of the cut [*be-qetzev ha-ḥittukh* (?)]: run it out until you pass the far point by the measure of the perpendicular [?]. You will by then have found this matter [set out] with the lines, [with] the thread upon this degree [*ha-maʿalah*] — this is it. And with this same graduation the depth too [is known], just as it was set out in the gate before this. Then, as the ratio of the digits [is to twelve, so is the ratio of the height] to [the distance] [?].

[Blue ink: **ואם**] And if [one] wishes to know the distance of the object [*merḥaq ha-davar*] [?] … then, just as [before], set them in proportion; and if the digits [give such-and-such], so [it falls] [?]. Therefore, when you know the digits, you know by that the height of the object [equals] [?] the perpendicular; and if [the reading is otherwise], the [thread] falls upon [?] … and thus you will know it by way of two sightings [*shtei reʾiyot* (?)] …

⚠ HIGHER-MAG RECOVERY (p.27 / 144r): The recurring graduation-term, unread on the first pass, is now recovered as **האצבעות** ("the digits" — the shadow-square divisions), with the base value **י״ב (twelve)** legible throughout; the umbra proportion (digits : twelve :: height : distance, and the perpendicular/depth complement) is now committed at clause level. Residual [?] marks fine sub-

clauses (*bi-qav sifrekha*, *be-qetzev ha-ḥittukh*, the exact pairing in the closing ratio) that remain at the cursive floor.

[The left ~55% of every line on this folio is blank margin; the text block sits to the right. The foot of the folio is blank.]

Fol. 144v …the matter is reckoned by proportion, and its height [is thereby found]. So too here [?] … After this, take the [reading] a second time; and [the height] will be what lies between the first place [reading] and [the second], [measured] from the raised side [?] until it is complete — such is the rule. [Blue ink: **ואם**] And if we wish to know [the height of] an object without needing to [approach] it [?] … as [with] the distance [*merḥaq*], and we set them in proportion [?] … [along the length] between it and the object [?]. Take [the reading on] the digits at a single place [?] upon [?] …

the digits upon which the thread falls, of whatever [number] they be — then as the ratio of the digits [is to twelve], so [is] the ratio of the height to the perpendicular [*ha-nitzavah*]; for as the ratio of the digits [is], so is the ratio of the distance to the perpendicular; and we say the ratio [is thus] [?] … and if [the reading falls] upon another place [?], and they are before you [as] two places [?], reckon [each] by its digits [?], and by that you will know [the object's position] [?].

[Red ink: **ואם**] And if the object is at a place lower [*namoch*] than the eye [?] … [then likewise for] the depth. Work the digits and the point of the thread by way of two sightings [*shtei re'iyot*], in the manner explained above; and continue in this way until you know the position [*ha-maqom*] of the object [?]. And if the object is at a place higher than the eye [?], [reckon] the height of the object [?] … and if it stands at one place [?], then the ratio of the distance [is to the height] as [the digits are to twelve] [?] …

[Red ink: **ואם**] And if [you sight it] at another place, the two places being before you [as] two [readings] [?] … take it a second time, so that you may know it by the two places [?] — the height or the depth [*ha-gova o ha-ʿomeq*], according to what preceded; and in every [case] we can proceed [likewise] in every position [?].

⚠ HIGHER-MAG RECOVERY (p.28 / 144v): The graduation-term is confirmed here too as **האצבעות** ("the digits"), and the proportion cases (digits : twelve :: height : perpendicular / distance : perpendicular) are now committed at clause level, along with the alternating higher-/lower-than-eye and one-place/two-place cases and the two-sightings (*shtei reʾiyot*) method. Residual [?] marks fine sub-clauses still at the cursive floor. No numerals are legibly present beyond **י״ב (twelve)**, "one" (*eḥad*), and "two" (*shtayim / bʾ*).

## [Gate 15, concluded] — General principles (kelalim)

[The body text sits as a short block in the right half of the page; the left half is blank margin. The general-principles passage begun at the foot of 144v continues here — a leveling/water-conducting rule for finding the gradient between two places. At 500-DPI the compact semicursive is now largely legible; securely-read words are committed and only genuinely unresolved spans remain flagged.]

to the place. When we [determine] [?] the distance between the two places, we reckon what must be added — that is, the height of the place where the water stands over the place where the resting-bed of its water settles [?]. … [?] and we divide this by the distance between them, and from it we learn [?] … so that the result comes out as one [part of the] ratio for every hundred cubits (*me'ah amah*) of the distance.

### [Closing rubric — end of the fifteen gates]

[A large decorative display statement in alternating red and blue rubrication at the foot of 145r. Fully legible at higher magnification; rendered as a continuous display block with ink colors noted.]

[Red ink] Behold, I have comprised in this — [Blue ink] in these gates — [Red ink] all — [Blue ink] that has been explained in the exposition of — [Red ink] the rest of — [Red ink] the instruments (*she'ar ha-kelim*).

[Black body prose, three short lines below the rubric on 145r:]

And even if the gates be many — in this [work] and in others — there is [?] within their totality everything, all that we need [?]… [?].

### [Display rubric — completion of the fifteen gates; announcement of Gate 16]

[A large red-ink display heading, fully legible at higher magnification. Set out line by line as a colophon-style block.]

[Red ink] The fifteen gates are complete (*tammu ט״ו she'arim*) — [Red ink] and we begin — [Red ink] Gate — [Red ink] 16 (ט"ז) — [Red ink] for to the makers of the work (*le-ʿosei ha-melakhah*, the craftsmen) — [Red ink] they entrust it (*yitnuhu*).

[The remainder of 145v is blank; only faint bleed-through from the following folio is visible. Gate 16 is announced here but its body text does not begin on this page.]

# The Sixteenth Gate

[Blue-ink display heading:] **The Sixteenth Gate** — [black caption, smaller hand:] on the making of the instrument.

We make a plate (*shulchan*) as large as we require, and it shall have [a pin/thread][?] standing perpendicular upon its center, [point] ה. We divide it into [?] equal parts, and we divide each quarter into ninety (צ) parts.

Then, from point ג [Stage-5 corr.: prior "point ד–ג" mis-segmented ג נקדת ("the point ג") — the ד belongs to the word נקדת], we set off toward [one side] according to the measure of [its declination][?], and we make a mark on it. We lay the line of the equator (*kav ha-mishor*, the level line) upon point ג [Stage-5 corr.: prior "point ד–ג" mis-segmented ג נקדת ("the point ג") — the ד belongs to the word נקדת] and upon the mark; and at the place where this line intersects, we make a mark there and write there [the letter] ז. And we lay [the ruler] upon its center, at the distance that is upon [point] ג, [along the line] that passes over it, as [at Cancer][?].

Then, again, we set off from point ג [Stage-5 corr.: prior "point ד–ג" mis-segmented ג נקדת ("the point ג") — the ד belongs to the word נקדת] toward the side [by the like amount][?], and we do the same, and we make there a mark, and make another like it outward. We lay the line of the equator upon point ג [Stage-5 corr.: prior "point ד–ג" mis-segmented ג נקדת ("the point ג") — the ד belongs to the word נקדת] and upon the mark; and at the place where this line intersects outward, we make a mark and write on it [the letter] ד. And we lay [the ruler] upon its center, at the distance that passes over it, as [before][?] — [so that it stands] upon half the circle of the zodiac (*galgal ha-mazalot*), the smaller one.

[Red ink, paragraph opener:] **Further** — we can also make these points by another method: from point ד, [dividing off] its sides according to the parts of the declination (*ha-netiyah*), and we make a mark on each one. And if we lay the line of the equator upon point ד and upon each of the marks[?], [we obtain the

points]. And if we wish, [we take] from point ד as center, [dividing off] its sides according to the parts of the declination, and we make a mark of this kind at each of the marked points; and we lay the line of the equator upon point ד and upon the mark, [and so we find them]. [We take the ruler and mark toward … according to the parts of …][?] the declination inclines[?] from the point toward [side] ג.

[fol. 146v]

a line equal to the line drawn from line ד–ה; there shall be the center of the plate (*ha-shulchan*) that stands upon that horizon.

[Blue-ink display rubric:] **[?][המצע / המצא]** — as we wished to make a circle, [we set off] from [one] point and from point [ד][?] toward [the side]; and we divide it into [equal] parts by number, and [lay] the line of the equator upon [point ג [Stage-5 corr.: prior "point ג–ד" mis-segmented ג נקדת ("the point ג") — the ד belongs to the word נקדת]][?] and upon the divisions, and where it intersects [the points, there they are marked] — whether to the north or to the south.

Then we make [the like] again, drawing each circle, and we make this part [a circle]: two circles, one [running] outward — we draw [the circle] that goes upward to the end of its completion (*takhlit*), and the one outward that reaches [downward] to the end of the [minutes][?]. And these two circles are about its center [ז][?]; and we divide it into portions, and we hang a peg (*yated*) upon it [for] however many degrees on the circle of uprightness (*galgal ha-yosher*, the celestial equator). Then we divide the whole line into a number of equal parts.

[Red ink, section rubric:] **And the method of inscribing the stars.**

The rationale of the operation is to bring out the fixed stars (*ha-kokhavim ha-kevu'im*) upon [the instrument]: [we take] the sides of the diameter of the degrees which is [the level line][?] — according to the measure of the distance of the star from the sphere of the zodiac (*galgal ha-mazalot*) — [taking that] from them, and the remainder is the diameter (*koter*). We divide it into parts, and at the place of division we set [a mark], and [take] its center toward [that point on the zodiac sphere][?].

Then we make a circle that passes [about that point] as about a pole (*kotev*); and [we take] the place of the star by its longitude on the sphere of the zodiac; and at the place where this circle intersects [the longitude], there is the place of the star.

And when we wish to bring out the southern stars, we make, from point ג [Stage-5 corr.: prior "point ג–ד" mis-segmented ג נקדת ("the point ג") — the ד

belongs to the word נקדת] toward one side, [an offset] like the declination, and according to [the amount belonging to][?] that star, and we make there a mark. We lay the line of the equator upon point ג [Stage-5 corr.: prior "point ג–ד" mis-segmented נקדת ג ("the point ג") — the ד belongs to the word נקדת] and upon the mark; and at the place where this line meets, outside point ג [Stage-5 corr.: prior "point ג–ד" mis-segmented נקדת ג ("the point ג") — the ד belongs to the word נקדת], we make a mark. And likewise we do [for the rest]: we divide the line that lies between the marks that were made for them into parts, and that shall be the diameter; and at the place of division shall be the center for the great [circle] of the southern [path][?] which is drawn for that star.

After this we make a circle that passes [about that center], just as on the sphere of the zodiac; and [we take] the place of the star on the sphere of the zodiac by its longitude, just as we did with the northern stars. And at the place where this circle meets the southern circle, there is the place of the star.

And because this work is long, we have taken for it a shorter method — namely, that we hang the plumb-thread (*ha-chut*) from the seat of the equator (*matzav ha-mishveh*), and we set upon it a pointer (*moreh*); and we thereby know the measure of the star's distance from the equator, whether to the north or to the south, from the declinations (*ha-netiyot*). And [thus] we know [its place] … [end of the written text on this side].

# Roba' Yisrael — batch 017 (ff. 147r–147v)

## Fol. 147r — conclusion of Gate 16, and the end of the treatise

*[Script: compact Sephardic semicursive, dark well-preserved black ink. Text occupies only the top ~6 lines; the remainder of the recto is blank. No drawn diagram or ruled star-table appears — the star material remains method-prose, as through Gate 16. Faint bleed-through of the verso's rubric is visible lower on the page and is ignored.]*

*[This paragraph continues directly the "shorter method" begun at the foot of 146v — hanging the plumb-thread from the seat of the equator with a pointer to read a fixed star's declination. Re-read at 500 DPI: the technical nouns and the two-branch structure are now secure; a single numeral in line 1 and two connective particles remain at the cursive floor and are flagged.]*

The pointer passes over the star at the degree of declination [*ha-nogah* — here a synonym for the declination]. And if this star is southern, [reckon it from(?)

[numeral: ?]] so that the pointer stands at the degrees of declination [*ha-netiyah*] according to this number; and if it is northern, so that the pointer stands at the known degrees [*ha-ḥalakim ha-yeduʿim*] according to this number.

Then set the thread [*ha-ḥut*] and the pointer [*ha-moreh*] fixed in their position until the thread comes to rest upon the degree that coincides with the star at the degree of declination; and at the point where the pointer meets it, you will see the star there — for that is its place [*ki sham hu mekomo*].

**The end.** [Colophon, fol. 147r foot of text-block: ∴ *תם* — ∴ תם ("finished") is clearly legible, framed on the right by ornamental dots (∴) and on the left by a matching scribal flourish. No dated colophon and no *tam ve-nishlam* / *tehillah la-El* formula is present. A faint trailing cluster to the left of *תם* is at the cursive floor and cannot be securely resolved as a word — most likely decorative ornament, possibly *ונשלם* ("and completed"): `[?]`.]

**The *Roba' Yisrael* ends here, on fol. 147r.** Gate 16 (the construction and use of the instrument) closes with the plumb-thread/pointer method for reading a fixed star's declination, and the treatise concludes with the plain terminal *תם*. The rest of the recto is blank.

## Fol. 147v — incipit of a DIFFERENT work: *Keli ha-Neḥoshet* (Ibn Ezra)

*[Fol. 147v begins a separate treatise — Avraham ibn Ezra's Sefer Keli ha-Neḥoshet (the astrolabe treatise). Its body belongs to `ibn_ezra/keli_ha_nechoshet_heb1031` and is NOT translated here. Only the transition/incipit is recorded, to confirm the work boundary. Incipit verified verbatim against the verso at high magnification.]*

Blue-ink incipit heading (verbatim, two centered lines):

- `[Blue ink header:` בשם בורא ים ויבשת`]` — "In the name of the Creator of sea and dry land"
- `[Blue ink header:` אתחיל ספר כלי הנחשת`]` — "I begin the Book of *Keli ha-Neḥoshet* (the Instrument of Bronze)"

Below the heading follows an introductory passage in red ink (rhymed/rubricated) opening ברוך יוצר... שפה והחכם..., then the treatise body begins. A red rubric appears further down the verso. All of this is the *Keli ha-Neḥoshet* and is left to its own work-file.

`` — at the foot of fol. 147v (bottom margin), pertaining to the *Keli ha-Neḥoshet* text continuing onto the next folio; not part of the *Roba' Yisrael*.

**Confirmed: fol. 147v is the start of a new, separate work. Translation of the *Roba' Yisrael* is complete.**